The impact of evolution on scientific method

Any effort to understand what is now taking place in human consciousness must of necessity proceed from the fundamental change of view which, since the sixteenth century, has been steadily exploding and rendering fluid what had seemed to be the ultimate stability—our concept of the world itself. To our clearer vision the universe is no longer a State but a Process. The Cosmos has become a Cosmogenesis. And it may be said without exaggeration that, directly or indirectly, all the intellectual crises through which civilization has passed in the last four centuries arise out of the successive stages whereby a static *Weltanschauung* has been and is being transformed, in our minds and hearts, into a *Weltanschauung* of movement.

Pierre Teilhard de Chardin

THEMATIC REMARKS

When philosophy undertakes to assess the cultural state of intellectual development at any given historical moment, it is obliged principally to clarify basic problems and to indicate the manner in which one problem bears on another, by discriminating the distinctions and interrelations of the basic areas of human concern and by imparting a grasp of the distinctive methods appropriate to dealing with each. To discharge this obligation is no mean task. It requires an appreciation of the past and an understanding of the present in the light of that appreciation. Doubtless this explains why the great teachers of the race have always mani-

fested a philosophic spirit, for the great teachers are those who cherish the wisdom of the past and make it relevant to the present; and it is through teaching and learning that civilization is sustained, disseminated and developed.

In dealing with the question of evolution, the successful discharge of the philosopher's synthetic obligation depends on his disposal of a distinctive difficulty. For the idea of evolution is the product of the "Darwinian revolution," which, in series with the "Copernican revolution" and the "Freudian revolution," is generally understood to mark a radical rupture with the past in man's consciousness both of his own nature and of the nature of the physical world.

In what possible sense does an appreciation of Classical Antiquity contribute to an understanding of Darwin's world? And on the practical side, how, in the limited space of a general essay, could one express that contribution, assuming there to be such?

An answer to these questions was suggested to me by taking together a contention implicit in Bernard J. F. Lonergan's book, *Insight*, and the architectonic around which W. T. Jones developed his admirable *History of Western Philosophy*.

Jones points out that a philosophy is simply a set of propositions dealing with the "big" questions about the ultimate value and meaning of life, about the structure of reality. By various criteria taken together, it is not difficult to discriminate in the flux of history the main lines of the dominating systems of human thought. First of all, to be a dominating system, it is necessary that a given philosophy constitute a perspective which satisfies a large number of people for a relatively long time. By this criterion, "the influence of a philosopher may be found in forms of speech, distinctions, and information anonymously imbedded in a later civilization as truly as in the explicitly labelled doctrines which a given age attributes to him,"[1] i.e., once the distinctions, terms, and guiding principles taken over from a philosophy are transmuted by familiar use into the accustomed materials of a culture and tradition, a philosophy can endure and provide a satisfactory perspective for millions who, as likely as not, have never heard the name of the authors of the perspective.

Secondly, a philosophy, to be such, must endure not only statistically, but also critically. If it is not to be a mere part of the cultural presuppositions of an age, indistinguishable from superstition and naive belief, a philosophy must be defensible before the bar of reason. To qualify as a reasoned set of beliefs, the various answers afforded by a philosophy to the various "big" questions must be mutually consistent. To the extent that what a philosopher says in psychology, for example, undermines what he says in ethics, the quality of his philosophy will be impaired.

[1] Richard McKeon, "Introduction" to *The Basic Works of Aristotle*, ed. by Richard McKeon (New York: Random House, 1941), p. xi.

Finally, over and above freedom from contradiction, the main lines of a philosophy must exhibit integration before they can dominate human thought. If a philosopher's teaching reflects no more than the perspective of one society, the philosopher's teaching will become irrelevant when that society changes in an important way. Conversely, in the measure that any philosophy contains a rationalization of the social conditions that exist at any given time, it becomes obsolete as the conditions of social life undergo transformation. Thus, on the one hand, a philosophy is adequate just to the degree that its principles are capable of coming to grips with all of the implications of all of the big questions; while, on the other hand, since, as the economic basis of life shifts, the big questions are posed with a differing emphasis and insistence in different ages, it is impossible for any philosopher ever to formulate once and for all a world-view satisfactory on all counts in all periods. But the essential point contrasting this criterion of integration against the criterion of freedom from contradiction rests on the difference between a philosophy which treats problems in isolation, be it a logical or socio-cultural isolation (an eclectic philosophy), and a philosophy in which the underlying principles or organizing parts are each one already virtually the whole (an organic or dialectical philosophy).

Using these criteria, Jones finds the architectonic for any study of Classical Antiquity blueprinted in advance:

> Now, even the most cursory survey of the history of Western thought shows two—and only two—periods in which a really great philosophy, in the sense in which we have defined that term, was developed. These periods were the fourth century B.C., when Plato and Aristotle worked out views which on the whole satisfied the classical world, and the thirteenth century A.D., when St. Thomas performed the same function for medieval man. . . . Compared with such enduring syntheses as these, the modern mind has produced as yet only a variety of tentative solutions. . . . One reason for our failure is the complexity of modern life. It was literally possible for a man like Aristotle to take all knowledge for his province. When Bacon made this claim in the seventeenth century, it already seemed bombastic. Today it would be fantastic. . . . Thus, what an Aristotle or a Thomas could achieve in the way of a real synthesis of all knowledge is becoming increasingly difficult, if only because of the sheer quantity of knowledge.[2]

[2] W. T. Jones, *A History of Western Philosophy* (New York: Harcourt, Brace & World, 1952), "Introduction," pp. xi-xii. Jones goes on to say in a later passage: "With Kant [1724–1804] we come, in fact, to another major synthetical effort, comparable, at least in scope, to the Platonic-Aristotelian and Thomistic syntheses. Though it failed to establish itself, as they did in their time, it nevertheless has had its own form of endurance" (p. 813). Some of the reasons for my own negative answer to the question of whether Kant represents a third alternative explanatory mode in addition to what will be called in this essay the Platonic and Aristotelian modes of explanation are indicated in fns. 55, 119, 131, 132, and 166 below. Cf. also John N. Deely, "The Philosophical Dimensions of the Origin of Species," Part II, Sec. VII, *The Thomist*, XXXIII (April, 1969), pp. 290–304, which contains a discussion of what may be termed, after Democritus (c. 460 B.C.), the Democritean, mechanistic, or atomistic explanatory mode. The same matter is discussed in the second reading of Section IV of this volume, B. Ashley's "Change and Process."

It is recognition of this last fact, commonly referred to today as the "knowledge explosion," that makes the philosopher's pedagogic task seem at first glance practically insuperable. Even granting that an appreciation of Classical Antiquity depends principally on a grasp of the main systematic lines of just three thinkers, and supposing further that an appreciation of these lines would lead to a greater understanding of Darwin's world (which has yet to be shown), from what point of view or within what perspective could one adequately delineate that understanding within the limits of a single essay?

If it is true that the content of mankind's knowledge is "so extensive that it mocks encyclopedias and overflows libraries," "so difficult that a man does well devoting his life to mastering some part of it," and "so incomplete and inadequate that it is subject to endless additions and repeated revisions," does it not follow that any cherishing of the "wisdom" of the past is hopeless antiquarianism, and that any attempt to relate such wisdom to the present is not merely arduous, but impossible?

It is here that Lonergan's approach to the problem of human understanding suggests a solution to our difficulty. As a matter of fact, there is not only the experimental level of knowing, wherein knowing is specified according to the various sciences of the phenomena of nature, and within these sciences endlessly diversified by the discovery of new things and new aspects of things; there is also another level of knowing wherein knowledge itself is universalized and unified, the sphere of a critique of knowledge or *critica* in the most proper sense, a pure reflexion upon the knowledge of things "outside" the mind (and in that sense a cognitive activity secondary by its very nature as well as in time), but a sphere or level in which it becomes possible to show "the organic diversity and essential compatibility of those zones of knowledge through which the mind passes in its great movement in search of being, to which each one of us can contribute only tiny fragments, and that at the risk of misunderstanding the activity of comrades devoted to other enterprises equally fragmentary, the total unity of which, however, reconciles in the mind of the philosopher, almost in spite of themselves, brothers-in-arms who knew not one another."[3]

To assess the post-Darwinian era in the light of the experimental sciences of Classical Antiquity (a very dim light to work by) would indeed be a hopeless and dubious task. But if we take as our primary concern not the *known* of the respective eras but the *knowing itself* exercised throughout them, and if we deal with this activity of knowing, so far as it is immanent in the Darwinian revolution, against the main epistemological lines traced within the systems of Plato, Aristotle, and Aquinas, then the synthetic

[3] Jacques Maritain, *The Degrees of Knowledge*, trans. from the 4th French edition under the general supervision of Gerald B. Phelan (New York: Scribner's, 1959), "Preface," p. xi.

obligation imposed on philosophy when it turns its attention to an exposition of the idea of evolution no longer seems impossible to discharge—even within the limits of a general essay.

> The known is extensive, but the knowing is a recurrent structure that can be investigated sufficiently in a series of strategically chosen instances. The known is difficult to master, but in our day competent specialists have laboured to select for serious readers and to present to them in an adequate fashion the basic components [the typically distinctive noetic features, let us say] of the various departments of knowledge. Finally, the known is incomplete and subject to revision, but our concern is the knower that will be the source of the future additions and revisions.[4]

Thus, while an account of knowing cannot disregard the content of knowledge ("the task of critique cannot for one single instant dispense with the knowledge of reality without having recourse to an illusory autophagic process"[5]), to provide a discriminant or determinant of cognitive acts, that content need be treated only in a "schematic or incomplete fashion."[6] And by grounding ourselves in the principal reasons and modalities of the movement of the mind in quest of truth, and of those phases through which it passes as, step by step, starting with sense experience, it enlarges, deepens, and transforms its own life, we find ourselves at about the one point of departure from which it is reasonable within the limits of a general essay to survey the landscape of Darwin's world from the summit of Classical Antiquity: "Thoroughly understand what it is to understand, and not only will you understand the broad lines of all there is to be understood but also will you possess a fixed base, an invariant pattern, opening upon all further developments of understanding."[7] "From this point of view it may also be said that the work which metaphysics is called upon to do today is to put an end to that kind of incompatibility of temper which the humanism of the classical age had erected between science and wisdom."[8]

This brings me to my final thematic observation. While agreeing with Jones that "we today are still in an era of experiment and preparation like those eras which preceded the Greek and medieval synthesis, and [that] it would be optimistic to expect any sudden condensation of our modern diversities into a satisfactory view,"[9] still, by assessing the passage

[4] Bernard J. F. Lonergan, *Insight: A Study of Human Understanding* (New York: The Philosophical Library, 1965), "Introduction," p. xviii. Cf. Aristotle's *Treatise on the Parts of Animals (De partibus animalium)*, Bk. I, ch. 1, 639a1–15.
[5] J. Maritain, *The Degrees of Knowledge*, p. 75.
[6] B. Lonergan, *Insight*, p. xvii.
[7] *Ibid.*, p. xxviii and p. 748.
[8] J. Maritain, *The Degrees of Knowledge*, p. xi. See Maritain, "The Conflict of Methods at the End of the Middle Ages," *The Thomist*, III (October, 1941), esp. Sec. V, pp. 536–538.
[9] W. T. Jones, *A History of Western Philosophy*, p. xii.

from Classical Antiquity to Darwin's world from the standpoint of the logic of the epistemological types of rational knowledge—which is essentially the standpoint of modern philosophy, i.e., of philosophical inquiry since the Renaissance, preoccupied as it is with questions concerning the nature of knowledge and its limitations—we may hope to contribute in some measure to an understanding both as to why "such positive concepts as have survived modern philosophy's own critical barrage are physico-mathematical in character," [10] and as to why "these have yet proved too narrow for a world-view of the kind Aristotle or St. Thomas attained." [11]

The pages that follow therefore cannot be read as an attempt to provide a handbook of answers, but only as an attempt to extend an invitation for personal reflection on the import of evolutionary science as regards the overall outlook on life and knowledge, and to provide a guide for further research.

In view of the scope and importance of the issues involved, the reader who wishes to pursue the points at issue further will find in the footnotes occasional illustration and development of key conceptual points likely to be misunderstood or open to dispute, together with what I hope are adequate references to the differing views on the key issues; but it has been impossible within the limits an essay must respect to indicate all the sources that have been necessary to document and establish the thesis that follows. I must rely on the reader's own general background in hoping that the restricted documentation finally incorporated within the notes to this essay shall prove sufficiently extensive.

These last remarks, of course, apply principally to interested readers themselves actively engaged in research. But it has also, and principally, been my intention and hope to write an essay sufficiently straightforward and clear that the ordinary undergraduate student with an interest in his world might come by reading it to sense the movement of history and the point at which today we stand in the cultural struggle toward a balanced differentiation of the inquiries restlessly pursued by the human mind.

[10] *Ibid.*

[11] *Ibid.* Jones goes on to observe summarily that "the outstanding fact about modern philosophy . . . is its inability to achieve anything remotely like a satisfactory synthesis of the historic past with the contemporary world-view, which is largely based on the findings of modern science" (pp. xii–xiii). According to Mortimer J. Adler (in *What Man Has Made of Man* [New York: Ungar, 1957], p. 242), the only contemporary exception to this generalization is Jacques Maritain. Be this as it may, one contribution I hope to have made in the present essay is a disengagement of some of Maritain's key insights into the history and nature of modern science from the expressly polemical and apologetic contexts in which he inclines to set them, often erecting thus—as even Adler openly admitted (in *St. Thomas and the Gentiles* [Milwaukee: Marquette University Press, 1938], p. 15)—an unfortunate barrier to the sharing of his insight beyond "the narrow circle of those who share with him, initially, a common ground." In this same respect, I hope to have contributed a clarification of the true sense of the notion of "empiriological" science—see Section III-A below of this present essay, and Secs. III and VII of my assessment of "The Philosophical Dimensions of the Origin of Species," *The Thomist*, XXXIII (January and April, 1969), pp. 93–102 and 290–304, respectively.

Let us proceed then to our consideration of the importance of evolution for the account of what science itself is, by indicating in a summary way the difficulty and scope of the issues involved.

To some thinkers it might seem superfluous to call attention to the very special nature of the problem of origins and development of natural entities. Yet if the term "evolution" is not reduced to the mere concept of observable change, it must be so used as to involve a problem more difficult and obscure than history itself. The origins of nebulae, physical and chemical elements, life, the multitudes of organic species including man, mind, and human culture, are essentially questions of *prehistory*. They are events and processes unwitnessed and unrecorded, events which took place millions and billions of years ago. This very obvious dimension of our problem imposes a less obvious and sometimes completely overlooked condition of its solution. The problem of prehistory places serious limitations on the expectancy of a completely satisfactory solution; and yet, prehistory has turned out to be the ultimate mystery of nature so far as human existence is concerned, for it has become increasingly clear that human history cannot be properly understood, let alone interpreted, unless it is regarded as in some way an *extension* of natural history, i.e., of prehistory.

One should be clear on the formidable difficulties this entails in the effort to achieve a view of the development of mankind, and particularly of the growth of civilization, which is to serve as the adequate (as opposed to ideological) basis for an integral humanism. If many problems of historical science, which has the great advantage of some written documentation, remain inaccessible to the human mind and admit of only highly conjectural resolution, how much more the problems of cosmological origins and organic prehistory!

To speak exactly, evolution does not pose a *problem* for contemporary thought so much as it presents itself as the necessary *background* concept for issues crucial in all areas of humanistic thought. In its essential import, as we shall see, evolution is not so much a philosophical concept as it is a summary expression of the realization, gradually secured within human experience, that nothing in the universe seems exempt from radical transformation. That is the sense and justification of C. H. Waddington's comment that "however they may be thought about, the facts of evolution and development simply cannot be omitted from any discussion of the human condition which hopes to carry conviction at the present time."[12] Thus evolution is less a particular theory (neo-Darwinian biology, for example) than a fundamental and absolutely primary datum, in the very

[12] C. H. Waddington, *The Ethical Animal* (New York: Atheneum, 1961), p. 74.

precise sense binding on philosopher and scientist alike, of exhibiting itself as a physical (i.e., observable) record of past occurrences for which no logical construction can be substituted and upon which all the logical constructions in our understanding of nature finally rest.

Consequently, from the point of view of the philosopher, evolution does not constitute a philosophical study in its own right. There is no such thing as "evolution in general," no study of "evolution as such," of "evolution inasmuch as it is evolution." There are only the changes which take place in the interaction of the diverse kinds of cosmic entities, and the relations of interdependence which obtain between the various levels of their cosmic interaction. There is nothing in the known evidence to warrant the assumption that evolution is the expression or product of a single, harmonious plan or law, rather than of a multitude of lines of causality in a universe full of chance and accident.[13] This may seem to be an obvious point, but obvious or not, its importance cannot be overstressed. For the fact of evolution too easily becomes, in the mind which has no eye for essential distinctions, an ideology of evolutionism.

All is not change, but all is changing: the whole of nature exists in and through process. That is all that the fact of evolution testifies. It is why, for the philosopher, evolution, without necessarily becoming itself the exclusive object of his investigations, nonetheless provides a kind of proving ground or "authenticity test" for diverse lines of philosophical analysis, sometimes pertaining to metaphysics, sometimes to politics or society, sometimes to the human existent as such, sometimes to moral questions, sometimes to religion, sometimes to culture, etc. The world into which Darwin led us, therefore, is not an easy world to understand, nor is it a particularly comfortable or comforting sort of world. But it is a real one; it is the world that makes us and, wittingly or not, the world in which we live. And just because, as we shall see, the evolutionary process which bears us along has an inexorable automatism about it, such that it may be influenced and guided but cannot be suppressed or halted, "it is a characteristic of this world to which Darwin opened the door that unless *most* of us do enter it and live maturely and rationally in it, the future of mankind is dim, indeed—if there is any future."[14]

To this end of making possible a rationally mature life within the "world into which Darwin led us," I hope to make some lasting contribution by the following analysis of the type or kind of explanatory structure

[13] Even Teilhard de Chardin, that most convinced "directionalist," acknowledged the limits of the evidence on this score: see, *inter alia*, *The Phenomenon of Man* (New York: Harper, 1959), pp. 231–233 and 284. Cf. also Theodosius Dobzhansky, *Mankind Evolving* (New Haven: Yale, 1962), p. 17; Charles de Koninck, "Réflexions sur le problème de l'indeterminisme," Part I, *Revue Thomiste*, XLII, No. 2 (juillet–septembre, 1937), p. 232ff., esp. pp. 234–5; and J. N. Deely, "The Philosophical Dimensions of the Origin of Species," Part II, pp. 298–318.

[14] George Gaylord Simpson, *This View of Life* (New York: Harcourt, Brace & World, 1964), p. 24.

evolutionary thinking represents, and of the essential observational difference between the world-view of classical antiquity and the evolutionary world-view.

I. THE EVOLUTIONARY CONCEPT

To so much as glimpse the developmental transformations that have gone into all that we are and see around us, and which are subsumed under that ultimate abstraction and dominant category of contemporary culture, "evolution," is no easy task. It requires that one not only familiarize himself with the characteristic evidences of the astronomical, geological, and biological sciences, especially paleontology or the study of the fossil forms. It demands also that one allow his imagination to quicken in order to interrelate these data after the manner of a motion picture. An actual film run at high speed can be used to reveal processes so slow as to escape ordinary observation, such as the growth of a plant, the transformations of an animal embryo. Similarly, our imaginal film of evolution, by altering our time scale, can startle us into awareness of the extent and rhythm of processes subtending the cycle of individual lives and deaths which alone imposes itself upon our everyday consciousness. Restricting ourselves for the moment to the record of living things, if we run our "film" of evolution at the rate to which our senses are accustomed, we see only the processes of individual development and destruction to which we are accustomed.

> With a hundredfold speeding up, individual lives become merged in the formation and transformation of species. With our film speeded up perhaps ten thousand times, single species disappear, and group radiations are revealed. We see an original type, seized by a ferment of activity, splitting up and transforming itself in many strange ways, but all the transformations eventually slowing down and stabilizing in specialized immobility. Only in the longest perspective, with a hundred-thousand-fold speedup, do over-all processes of evolution become visible—the replacement of old types by new, the emergence and gradual liberation of mind, the narrow and winding stairway of progress, and the steady advance of life up its steps of novelty.[15]

That is one of the first and most fundamental lessons one learns from acquaintance with evolutionary studies: the simple insufficiency of a conceptual horizon restricted to the span of written history and to the data of common sense observation, for posing the question of man's place and rôle in nature. For within such an horizon it is a basically *unchanging* world which seems to confront our gaze; whereas we know in

[15] Sir Julian Huxley, *Evolution in Action* (New York: Mentor, 1953), p. 28.

fact that ours is a basically *changing* world, a world in which nothing, no individual and no sector or region, is free from radical transformations. To keep to the terms of our metaphor, "with respect to the evolution which has actually taken place in the history of the earth, an observer of only the now-living animals and plants is still in a position of judging a long movie film by only the last picture frame."[16]

This lesson comes across still more dramatically when one considers not only the history of life as revealed by the fossils—be they potsherds or bones—but also the vast forces at work in the establishment of an environment wherein life became possible in the first place, and the problem of the initial passage from the inorganic to the living.

Let us imagine, for a moment, that the 4,700 million odd years of our planet's past are represented by the distance of one hundred miles, and that we are walking from the time of the earth's origin towards the present. On the first half of our journey we encounter no living thing. After traversing a full eighty-eight miles, simplest invertebrates, resembling worms and jellyfish, begin to appear. At ninety-three miles, certain organisms—those, namely, pushed aside in the swamps and along the tideflats, the failures of the sea—begin the invasion of the land masses. Our own ancestral group, the mammals, does not appear until we have a scant two of our hundred miles left to cover. The whole of man's physical evolution since the beginning of the Pleistocene epoch will take place over the last sixty yards of our journey, and the span of written history with all its panoply of civilization will be traversed in the last half of our last stride!

Yet, our planet itself must likewise be seen in a context of process, immensely slow, it is true, even by biological standards, but equally irreversible and inexorable. So too our sun and galaxy. All reality, in fact, is in evolution, "definable in general terms as a one-way, irreversible process in time, which during its course generates novelty, diversity, and higher levels of organization. It operates in all sectors of the phenomenal universe but has been most fully described and analyzed in the biological sector."[17] It is a question first of all of learning to accept the brevity, the

[16] Theodosius Dobzhansky, *Evolution, Genetics, and Man* (New York: Science Editions, 1963), p. 284.

[17] Sol Tax and Charles Callendar, eds., *Issues in Evolution* (Chicago: University of Chicago Press, 1960), p. 107 (Vol. III of the University of Chicago Centennial, *Evolution After Darwin*). See John N. Deely's note on evolution as an interaction transcendental of natural philosophy, in "The Philosophical Dimensions of the Origin of Species," Part I, *The Thomist*, XXXIII (January, 1969), p. 129 fn. 108. Thus Raymond J. Nogar, in *The Wisdom of Evolution* (New York: Doubleday, 1963), p. 279, remarks: "The fundamental philosophical question which science of Darwin, Freud, Einstein, Planck and Heisenberg raises is: *what is the relationship, reality, between the change and stability of nature?* Evolution is an extremely generalized story of the process of nature, and today natural history is grossly incomplete without an account of evolutionary history. Yet there remains the predictable stability of nature which is subjected to the structure of natural laws. Science formulates the laws of stability as well as describes the

relativity, and the dependency of human existence upon a peculiar set of segmental laws of time and space; and secondly, of understanding these laws as but special cases of more general laws giving structure to space and time.

Thus, the evolutionary reality of itself divides before the mind into three main sectors or regions in which the general process is operative in quite different ways. Following Huxley,

> We may call these three phases the inorganic or, if you like, cosmological; the organic or biological; and the human or psycho-social. The three sectors of the universal process differ radically in their extent, both in space and time, in the methods and mechanisms by which their self-transformations operate, in their rates of change, in the results which they produce, and in the levels of organization which they attain. They also differ in their time relations. The second phase is only possible on the basis of the first, the third on the basis of the second; so that, although all three are in operation today, their origins succeeded each other in time. There was a critical point to be surmounted before the second could arise out of the first, or the third out of the second.[18]

In the inorganic or cosmic sector the tempo is much slower and the mode of change much different from the tempo and mode of change in the organic or biological sector of the universe. All comes about through physico-chemical exchanges, and the results must be measured by the lifespan of stars. (See Table I, p. 14.)

In the organic or biological sector the tempo is faster, measurable now by the appearance and extinction of whole new life-forms, by millions rather than billions of years. Here change is effected over the course of generations by modifications in biological heredity. (See Table II, pp. 16–17.)

With the appearance of man, still another dominant mode of change emerges: social heredity, the cumulative transmission of conscious experience. Now the tempo of change may be measured by the reorganization of the thought-patterns of human groups around new insights and values. This defines the peculiarly human, cultural or psycho-social sector of evolutionary development. (See Table III, pp. 18–19.)

Thus the anthropological problem is posed, and the idea of evolution emerges as the necessary background concept for any attempt in our day to construct an integral philosophical anthropology. For it is sufficiently clear—particularly from within the tradition of Christian thought which channels through St. Thomas Aquinas—that, as Simpson puts it, "the meaning of human life and the destiny of man cannot be separable from

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histories of change. What is the relationship between these two great efforts of nature?" Cf. also pp. 289–290, 298.

[18] Huxley, *Evolution in Action*, p. 10.

TABLE 1: THE COSMOLOGICAL SCALE OF SPACE AND TIME

A. The Scale of Space	
The Near Stars:	about 10 light years distant
Diameter of Our Galaxy (the "Milky Way" Star System):	100,000 light years plus
Diameter of Average Galaxy:	10,000 to 500,000 light years plus
Distance Between Galaxies:	1 million light years upwards (no real mean, since distance within as well as between galactic clusters would be involved)
Mass of Our Galaxy:	equal to 100 billion suns
Mass of Average Galaxy:	from 30 billion to 3 trillion suns
Number of Currently Photographable Galaxies:	1 billion (perhaps more than twice this number detectable with radio telescopes)
Number of Stars in Known Universe:	100 quintillions (10^{20})
Statistical Expectancy of Stars Supporting Planetary Systems:	1 trillion (10^{12})
Statistical Likelihood of Planetary Systems Suitable For Evolution of Organic Life:	100 million (10^{8}: minimal conservative expectation: some would multiply this number by a thousand, some by a million)
Extent of Visible Universe:	10 billion light years plus (and this approximates to the estimated depth of the universe in time)
B. The Scale of Time	
Age of Universe:	about 14 billion years (13 to 20 billion)
Age of the Galaxies:	6.5 billion years
Age of Our Sun:	5 billion years
Age of Earth:	4.7 billion years
Age of the Continents (in cooled state):	3.5 billion years
Age of Life:	2 to 2.5 billion years
Age of Oxidizing Atmosphere:	1 billion years
Age of First Clear Fossils:	600 million years
Age of Land Animals and Plants:	405 million years
Age of Dinosaurs:	230 million years
Age of Mammals:	63 million years
Age of Man:	between 1 and 2 million years
Recorded Human History:	5 to 6 thousand years
Time of Abraham:	circa 1800 B.C.
Continued Maintenance of Environmental Conditions Capable of Sustaining Life on Earth:	another 2.5 billion years (thus we of today stand at life's high noon on earth)
Time Until Earth is Destroyed by Sun:	another 4.5 to 4.7 billion years (thus we also stand midway in the history of planet earth)
Life Expectancy of Our Sun:	another 5 billion years

Man has learned to accept the brevity, the relativity, and the dependency of his own existence upon a peculiar set of segmental features of time and space, which are only special cases of more general space-time laws that he seeks to apprehend. Natural history has achieved a perspective in time of roughly 14 billion years, and a perspective in space approaching that same depth or extent. Between the advent of *animal rationale* and the start of the Biblical record, the history of man is tenuous, uncertain, and conjectural on the side of our knowledge, even as on the side of its actual working out it was precarious in the extreme. *What was man doing through all that time?* Struggling to become human, a state of accomplishment which still lies in the not near future. Yet short as it is in the drama of cosmogenesis (if the age of the earth were equalled to one calendar year, the presence of man on earth would account for one half-hour, and recorded human history for one and a half minutes), a History of Mankind allotting one page to every hundred year period would comprise a completed work of more than twenty volumes of a thousand pages each.

the meaning and destiny of life in general."[19] No less can the meaning of life in general be separated from the meaning and mystery of matter to which, in fact, life reduces as a peculiarly organized modality.[20] In final analysis the nature of man must link up structurally with that of the universe at large, even as the phenomenon of man at once presupposes (in the naturalist's sense) and yet (in the phenomenologist's sense) constitutes the phenomenon of world.

A. The discovery of evolution

The discovery of evolution began with the great voyages of exploration which put out from Europe in the late eighteenth and nineteenth centuries. Less auspiciously and more directly, it began with a few eccentrics or "hobbyists" associated for one or another reason with the great explorers, but themselves less concerned with the extension of military and economic empires than with "idly" collecting the diversity and debris of life. What began so immersed in contingency and dependent on chance has culminated, toward the middle of our own century (and indeed, for penetrating minds, considerably earlier), in a world-view fundamentally different from that of classical or medieval times, restricted, as they were, to the conceptual horizon of common experience and written documents. And with this new vision appeared what has come to define the conceptual horizon for all efforts at synthetic thought in our time: the problematic of evolution. "To a philosopher the cosmic, biological, and cultural evolutions are integral parts of the grand drama of creation," Dobzhansky

[19] George Gaylord Simpson, *The Meaning of Evolution* (New Haven: Yale, 1949), p. 9.

[20] In the Aristotelian tradition, this is clear in terms of the essential analysis of life both in terms of its primary formal effect (as the principle by which anything lives, feels, moves about in its environment, or understands primarily) and of its proper subject (as the fundamental actuality of a properly organized physical unit, where "properly organized" means simply organized in such a way as to enclose the capacity for self-augmentation and reduplication, the activities most proper to life). See Aristotle's *De anima* ("Treatise on the soul"), Bk. II, chs. 1 and 2.

Moreover, this same point is only a little less clear, indeed, in some respects, clearer, in the more generally empiriological formulations of modern authors. E.g., cf. Simpson, *The Meaning of Evolution*, pp. 126 and 291; G. G. Simpson, C. S. Pittendrigh, and L. H. Tiffany, *Life* (New York: Harcourt, 1957), pp. 16–17 and 35; T. Dobzhansky, *Evolution, Genetics, and Man*, pp. 19ff.; Pierre Teilhard de Chardin, *The Phenomenon of Man* (New York: Harper, 1959), p. 300. (On the sense of the phrase "empiriological formulations," see the discussion of dialectical or hypothetical facts in Division III of this essay, "World-View as *Logos* and as *Mythos*.")

On the relation of these two lines of analysis to each other and their concurrence on the problem of the origin of terrestrial life so far as it is a question of principle, see John N. Deely, "The Philosophical Dimensions of the Origin of Species," Part II, *The Thomist*, XXXIII (April, 1969), pp. 318–326, esp. pp. 323–324. On the question of the relation of the degree of organic heterogeneity ("complexity," if you like) to the level of vital activity exhibited by an organism and to the emergence of conscious organisms, see *ibid.*, pp. 301–331, esp. pp. 318–319 and fn. 264.

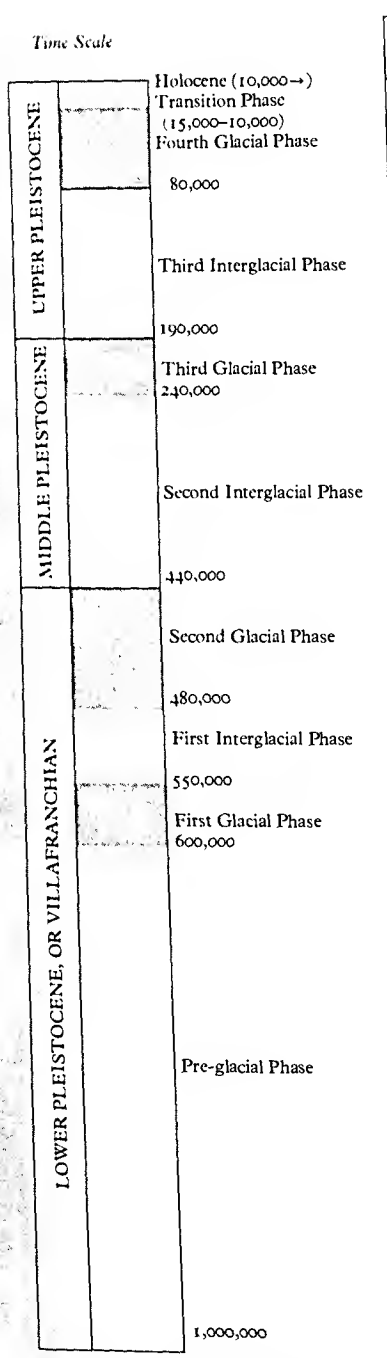
TABLE 11: GEOLOGIC TIMETABLE

Era	*Period*	*Epoch*	*Duration in Millions of Years*	*Time From Beginning of Period to Present (Millions of Years)*	*Geologic Conditions*	*Plant Life*	*Animal Life*
Cenozoic (Age of Mammals)	Quaternary	Recent	0.025	0.025	End of last ice age; climate warmer	Decline of woody plants; rise of herbaceous ones	Age of man
		Pleistocene ("most recent")	1	1	Repeated glaciation; 4 ice ages	Great extinction of species	Extinction of great mammals; first human social life
	Tertiary	Pliocene ("more recent")	11	12	Continued rise of mountains of western North America; volcanic activity	Decline of forests; spread of grasslands; flowering plants, monocotyledons developed	Man evolving; elephants, horses, camels almost like modern species
		Miocene ("less recent")	16	28	Sierra and Cascade mountains formed; volcanic activity in northwest U.S.; climate cooler		Mammals at height of evolution; first manlike apes
		Oligocene ("few of the recent")	11	39	Lands lower; climate warmer	Maximum spread of forests; rise of monocotyledons, flowering plants	Archaic mammals extinct; rise of anthropoids; forerunners of most living genera of mammals
		Eocene ("dawn of the recent")	19	58	Mountains eroded; no continental seas; climate warmer		Placental mammals diversified and specialized; hoofed mammals and carnivores established
		Paleocene	17	75			Spread of archaic mammal
	Rocky Mountain Revolution (Little Destruction of Fossils)						
Mesozoic (Age of Reptiles)	Cretaceous		60	135	Andes, Alps, Himalayas, Rockies formed late; earlier, inland seas and swamps; chalk, shale deposited	First monocotyledons; first oak and maple forests; gymnosperms declined	Dinosaurs reached peak; became extinct; toothed birds became extinct; first modern birds; archaic mammals common
	Jurassic		30	165	Continents fairly high; shallow seas over some of Europe and western U.S.	Increase of dicotyledons; cycads and conifers common	First toothed birds; dinosaurs larger and specialized; insectivorous marsupials

	Triassic		40	205	Continents exposed; widespread desert conditions; many land deposits	Gymnosperms dominant, declining toward end; extinction of seed ferns	First dinosaurs, pterosaurs and egg-laying mammals; extinction of primitive amphibians
	Appalachian Revolution (Some Loss of Fossils)						
Paleozoic (Age of Ancient Life)	Permian		25	230	Continents rose; Appalachians formed; increasing glaciation and aridity	Decline of lycopods and horsetails	Many ancient animals died out; mammal-like reptiles, modern insects arose
	Pennsylvanian (Carboniferous)		25	255	Lands at first low; great coal swamps	Great forests of seed ferns and gymnosperms	First reptiles; insects common; spread of ancient amphibians
	Mississippian (Carboniferous)		25	280	Climate warm and humid at first, cooler later as land rose	Lycopods and horsetails dominant; gymnosperms increasingly widespread	Sea lilies at height; spread of ancient sharks
	Devonian		45	325	Smaller inland seas; land higher, more arid; glaciation	First forests; land plants well established; first gymnosperms	First amphibians; lung-fishes, sharks abundant
	Silurian		35	360	Extensive continental seas; lowlands increasingly arid as land rose	First definite evidence of land plants; algae dominant	Marine arachnids dominant; first (wingless) insects; rise of fishes
	Ordovician		65	425	Great submergence of land; warm climates even in Arctic	Land plants probably first appeared; marine algae abundant	First fishes, probably freshwater; corals, trilobites abundant; diversified molluscs
	Cambrian		80	505	Lands low, climate mild; earliest rocks with abundant fossils	Marine algae	Trilobites, brachiopods dominant; most modern phyla established
	Second Great Revolution (Considerable Loss of Fossils)						
Proterozoic			1500	2000	Great sedimentation; volcanic activity later; extensive erosion, repeated glaciations	Primitive aquatic plants—algae, fungi	Various marine protozoa; towards end, molluscs, worms, other marine invertebrates
	First Great Revolution (Considerable Loss of Fossils)						
Archeozoic			???	???	Great volcanic activity; some sedimentary deposition; extensive erosion	No recognizable fossils; indirect evidence of living things from deposits of organic material in rock	

Reproduced from Edward O. Dodson, *Evolution: Process and Product*, by permission of Reinhold Book Corporation, a subsidiary of Chapman-Reinhold, Inc., New York, 1960. Dodson's chart was itself adapted from Villee, *Biology, The Human Approach*, 3rd ed., W. B. Saunders Co., 1957.

TABLE III: CHART OF QUATERNARY TIME



Geological Divisions			*Years Ago*	*Main Climatic Phases*
QUATERNARY PERIOD	HOLOCENE OR RECENT EPOCH		11,000	Modern Climates
	PLEISTOCENE EPOCH	UPPER PLEISTOCENE	15,000	Transition Phase; gradual retreat of the ice-sheets
			80,000	Fourth, or Würm, Glacial Phase (Wisconsin Phase in North America)
		MIDDLE PLEISTOCENE	190,000	Third Interglacial Phase (Sangamon Phase in North America)
			240,000	Third, or Riss, Glacial Phase (Illinoian Phase in North America)
			440,000	Second, or Great, Interglacial Phase (Yarmouth Phase in North America)
		LOWER PLEISTOCENE OR VILLAFRANCHIAN	480,000	Second, or Mindel, Glacial Phase (Kansan Phase in North America)
			550,000	First Interglacial Phase (Aftonian Phase in North America)
			600,000	First, or Gunz, Glacial Phase (Nebraskan Phase in North America)
			1,000,000 to 2,000,000	Pre-glacial Phase; transition from Pliocene Epoch

This chart has been devised to give a general picture of the geological, climatic, and archaeological phases of the Quaternary Period, with their associated fossils and human cultures. Most of the dates are still speculative and recent research suggests a rather greater antiquity for the Australopithecines than is shown here. The time scale on the left gives an approximate indication of the duration of the various phases; the remainder of the chart is diagrammatic only and is not drawn to scale.

(PERIOD OF MAN'S RISE TO DOMINANCE)

Characteristic European Fauna	*Archaeological Divisions*	*Main Cultures*	*Main Human and Subhuman Types*	*Years Ago*
	Modern urban society			
Existing species First domestic animals	AGE OF METALS NEOLITHIC	Metal cultures and civilisation. Advanced stone cultures	Modern races of *Homo sapiens*	
	MESOLITHIC	Campignian Erteböllian Maglemosian Tardenoisian Azilian		10,000
Steppe fauna REINDEER AGE (tundra fauna)	UPPER PALAEOLITHIC	Magdalenian Solutrean Gravettian Aurignacian Chatelperronian	Fossil races of *Homo sapiens:* Cro-Magnon Grimaldi and Chancelade	40,000
AGE OF WOOLLY MAMMOTH Woolly mammoth (*Mammuthus primigenius*) Woolly rhinoceros (*Rhinoceros tichorhinus*) Cave bear (*Ursus spelaeus*) Cave lion (*Panthera leo spelaea*)	MIDDLE PALAEOLITHIC	Mousterian	Neanderthal Man (*Homo neanderthalensis*)	160,000
AGE OF THE ANCIENT ELEPHANT Ancient elephant (*Palaeoloxodon antiquus*) *Mammuthus trogontherii* Merck's rhinoceros (*Rhinoceros mercki*) *Hippopotamus major* *Note:*—During this period the temperate and subtropical climatic belts with their associated faunas moved frequently north and south with the advance or retreat of the ice-sheets. The above are four characteristic mammals of the time.	LOWER PALAEOLITHIC	Levalloisian Acheulian Clactonian Abbevillian Choukoutienian Oldowan	Heidelberg Man (*Homo heidelbergensis*) Java Man and Pekin Man (*Pithecanthropus*) Australopithecinae and *Telanthropus* *?Zinjanthropus* (exact status and date of this fossil is still speculative)	600,000
AGE OF THE SOUTHERN ELEPHANT Southern elephant (*Elephas meridionalis*) Etruscan rhinoceros (*Rhinoceros etruscus*) Sabre-toothed cat (*Machairodus*)	?Origin of tool-making tradition		?Pre-Australopithecine sub-hominids (no known fossil evidence)	1,000,000

Based on Richard Carrington's "Chart of Quaternary Time" in *A Million Years of Man*, New York: The World Publishing Co., 1963, pp. 50–51.

muses, since "the human race with its social, intellectual, and artistic achievements, the world of living creatures, and inanimate nature all evolved gradually and by stages from very different antecedents."[21]

Thus, while the world was for centuries conceived principally in terms of *space*, today it must be conceived with primary reference to *time*, for its characterizing structural features are not self-identical in every region or at every period in the world's history. Bit by bit, the patient probing of the geographical zones and geological strata of our planet has disclosed that the world and its layer of life have not simply a record of change but a history of development, a history with an ontological content. The paleo-sciences reveal a retrospective, that is, a temporally receding, environmental sequence. They show us stratified cross-sections of the slow process through which the world had to build itself up from its simplest beginnings before it could support such life as we are familiar with.

From indiscernible beginnings in the sea, life began to multiply in number and kind, in a word, to *ramify*. Eventually, amphibious forms moved onto land, in their turn to ramify, preparing the way for entirely new metabolic organizations and so new dominant life-forms. The Age of Amphibia gave way to the Age of Reptiles, which would in turn yield to the Age of Mammals.

As the continental upthrust cooled the atmosphere, the great reptilian forms, lacking an internal temperature-regulating mechanism, became less and less able to maintain a minimal level of mental efficiency. At the same time, the emergence of the true flowering plants provided new and concentrated sources of energy that were quickly exploited by the warm-blooded mammals. Characterized by a high metabolic rate and the maintenance of a constant body temperature (homeostasis), the mammals originally consisted of squirrel-like little creatures living in trees and underbrush, wholly incapable of competing with the massive reptiles, and so confined to nocturnal and fringe environments of a reptilian world. But with the advent of the flowering plants and the cooling of the atmosphere, all this changed.

"Whirl is king," said Aristophanes, and never since life began was Whirl more truly king than eighty million years ago in the dawn of the Age of Mammals. It would come as a shock to those who believe firmly that the scroll of the future is fixed and the roads determined in advance, to observe the teetering balance of earth's history through the age of the Paleocene. The passing of the reptiles had left a hundred uninhabited life zones and a scrambling variety of newly radiating forms. Unheard-of species of giant ground birds threatened for a moment to dominate the earthly scene. Two separate orders of life contended at slightly different intervals for the pleasant grassland—for the seeds and the sleepy burrows in the sun.[22]

[21] Dobzhansky, *Evolution, Genetics, and Man*, pp. 5 and 1.
[22] Loren Eiseley, *The Immense Journey* (London: Gollancz, 1958), pp. 7–8.

The balance of life had been tipped, and the Age of Reptiles gave way to the Age of Mammals, and this new age in turn engendered the Age of Man. But it all took some two billion years. Built up by a multitude of interacting forces, including living things, the hierarchy of life step by step prepared the way for higher forms. And the type of environment defining the possibility of human beings extends far beyond the vision or experience of the things that live there. For all the extreme difficulty of getting information from which to draw by the methods of measuring prehistoric time reliable inferences, for all the dependency of the paleosciences upon interpolations, assumptions, extrapolations, and analogies, "the broad, overall picture of the succession of organic forms in space and time is too heavily documented by cross-checking and convergence of materials to be rejected by the objective observer."[23]

According to Bergson, "The evolutionist theory, so far as it has any importance for philosophy, requires no more. It consists above all in establishing relations of ideal kinship, and in maintaining that wherever there is the relation, of, so to speak, *logical* affiliation between forms, there is also a relation of chronological succession between the species in which these forms are materialized."[24]

B. The explanation of evolution

What Bergson is driving at is the fact that once an overall succession of organic forms in space and time had been established, once, that is to say, it was known that the now living life-forms had been preceded not merely by *other* forms but by specifically and typically *different* forms no longer existent, and these by still others, we have only two alternatives for explaining this succession. Either there has been a continuous development of life, or a discontinuous series of creations and extinctions. On either supposition, "we should still have to admit that it is successively, and not simultaneously, that the forms between which we find an ideal kinship have appeared." On the supposition of a discontinuous process, "evolution would simply have been transposed, made to pass from the visible to the

[23] Raymond Nogar, *The Wisdom of Evolution*, p. 63. See Theodosius Dobzhansky, *Genetics, and the Origin of Species* (3rd rev. ed.; New York: Columbia, 1951), p. 11, J. Franklin Ewing, "Precis on Evolution," *Thought*, XXV (March, 1950), pp. 59–60; W. LeGros Clark, "The Crucial Evidence For Human Evolution," *American Scientist*, XLVII (1959), pp. 299–300; E. C. Case, "The Dilemma of the Paleontologist," in *Contributions From the Museum of Paleontology*, IX, No. 5 (Ann Arbor: Michigan, 1951).

On the question of the aspect or element of necessity in evolutionary studies, i.e., on the question of their fundamentally authentic character as *science*, see Section IV of John N. Deely's article, "The Philosophical Dimensions of the Origin of Species," Part I, *The Thomist*, XXXIII (January, 1969), pp. 102–130, esp. pp. 112–129.

[24] Henri Bergson, *Creative Evolution*, authorized trans. by Arthur Mitchell (New York: Modern Library, 1941), pp. 29–30.

invisible," from the realm of the researchable to a forever unintelligible level. Such a gratuitous transposition, however, is not a rational option, either at the level of science, philosophy, or theology. This is an absolutely essential point.

The triumph of the theory of evolution as a concept, however ambiguous, metaphorical, or equivocal, is that it provides a means of synthesizing knowledge about the cosmos within a natural continuum of explanation. The order of nature cannot be described except in natural terms, the theory asserts; there is a natural bond connecting cosmic entities in their space-time continuum. As long as there is hope of joining the prehistories of cosmic species in a natural sequence by a natural explanation, cosmic problems remain in the province of natural science. No preternatural, miraculous, or special Divine Intrusion need be postulated until the possibility of these natural causal relationships be ruled out. This frame of mind is largely due to the achievement of evolutionary theory in underscoring the continuity of natural events in time and space and in insisting on searching for natural relationships among all natural events to make them intelligible in terms of natural causes. This is excellent natural science; this is the premise of realistic natural philosophy; this is axiomatic to the natural theologian.[25]

With a differing emphasis, Professor Georges Crespy illuminates this same fundamental issue. "Evolutionism is not only a scientific *theory*," he points out, "although it is principally this; it is also a *mentality*, an attitude of mind in facing the problems posed by understanding the phenomena of matter. If one attacks the 'gaps' in the theory of evolution —and since the theory of evolution is full of 'gaps' this is not at all difficult —then, in reality, one is attacking the evolutionist mentality, without saying so, and often even without knowing it."[26]

Yet the "evolutionist mentality" amounts to no more than a recognition of the intrinsic necessity for continual causal play throughout a natural developmental process. Organic evolution, understood simply and loosely as a natural process of change of successive generations, of new forms genetically and somatically related through space and time with old forms, does occur and has occurred for the total period of life on earth; and this evolution depends in its turn on those processes which gave form

[25] Raymond J. Nogar, "Evolution: Scientific and Philosophical Dimensions," in *Philosophy of Biology*, Vincent E. Smith, ed. (New York: St. John's University Press, 1962), pp. 54–55. Cf. St. Thomas Aquinas, *Summa contra gentiles*, I, ch. 42, n. 4; III, chs. 22, 76, 77, 83, 94 (available in five-volume English trans. from Image Books); *Summa theologica*, I, Q. 22, art. 3; Q. 103, art. 6. George Gaylord Simpson, *The Meaning of Evolution*, pp. 127–128. Ernst Mayr has a curt reminder for those who might incline to the expedient of projecting imaginal explanations from the basis of subjective preferences: "The complexities of biological causality do not justify embracing nonscientific ideologies. . . ." ("Cause and Effect in Biology," in *Science*, CXXXIV, November, 1961, p. 1506.)

[26] Public lecture delivered by Professor Georges Crespy of Montpellier, France, on "Evolution and Its Problems," under the sponsorship of the Chicago Theological Seminary, January 16, 1965 (p. 2 of mimeographed text). See Michael E. Ruse, "The Revolution in Biology," *Theoria*, XXXVI (1970), pp. 11, 14–15, 16–17.

to our planetary system within the galaxy. In this statement there are present all the dangers of extrapolation, all the limits of an incomplete fossil record, all the weaknesses of indirect evidence and inference. Yet one cannot deny this natural succession of species, genera, and classes of organisms without denying the whole fabric of the science of prehistory and the converging arguments adduced from every department of biology. Everything known about the process of development of organisms in genetics, embryology, morphology, taxonomy, natural history, ecology, cytology, physiology, biogeography, indeed, in every science of life, points to natural relationship and continuity of forms.

It is doubtless a lack of understanding on this point that lies behind so much of the confusion over key implications of evolutionary science in the realms of metaphysical and theological explanation. For example, it was with the just mentioned simple, absolutely fundamental and, understood rightly, incontestable philosophical principle in mind—the principle, namely, of the intrinsic necessity for continual causal play throughout a natural developmental process or series of processes—that the great theologian Sertillanges argued in 1945 (vainly, as it turned out) against the verbal opposition between "creationism" and "evolutionism," "as if these were two contrary notions." In fact, the idea of creation and the idea of evolution in their essential notes are mutually indifferent to one another, since "there is nothing to prevent us from seeing in evolution, instead of a substitute for creation, simply another perspective on the manner in which the creative fact (itself a polyvalent, metaphysical conception, that is, a conception denoting a truth not circumscribed by time or restricted to any particular empirical facet of reality) is bound up with the facts of nature."[27] For the idea of creation poses essentially neither a question of duration (whether the universe is eternal or had a beginning) nor a question of succession (whether the specific structures of the world are fixed or labile). It poses rather the question purely and simply of the total dependence of the real with respect to its existence, "*a question of dependence in being.*"[28] "The Ancients," like some moderns, "generally understood creation as an arrangement starting from a primitive chaos, the causes of which were not sought, either because of the infantile state of their general metaphysics, or because the First Necessity was envisaged by them as enveloping at the same time God and the stuff presupposed for his action."[29]

[27] A.-D. Sertillanges, *L'Idée de création* (Paris: Aubier, 1945), p. 128. (Translations from this work are by Simone Poirier Deely and John N. Deely.)

[28] *Ibid.*, p. 6. Cf. Jacques Maritain, *The Peasant of the Garonne* (New York: Holt, 1968), fn. 26, p. 267.

[29] *Ibid.*, p. 5. In the understanding of the idea of creation evinced in the writings of Pierre Teilhard de Chardin, for example, we seem to have a reversion to the conception of the Ancients on both counts. In terms of the Ancients' conception, such of Teilhard's writings as "La luttre contre la multitude" (1917), "L'union créatrice" (1917), "Note sur les modes de

But all that is not God is a creature of God, and so we find ourselves upon the horns of a dilemma: either there is no creation and the world is not created, or something which is not God escapes the causality of God. There is only one solution to the dilemma so posed, and it is a very poor one. Not finding an acceptable sense for the term creation, one could hold to the first horn of the dilemma just proposed and contend that the universe is not created by God, it is identical with God—which is the pantheistic [or monistic] thesis.[30]

"Does God act presupposing something or presupposing nothing at all?" This alone is the principal issue in the idea of creation.[31] Everything else is purely secondary, incidental with respect to what is constitutive of the creative fact and question, which belongs first of all to metaphysics, and to science or theology only by the way; whereas with the fact and question of evolution, this order of primary and secondary is exactly inverted.

Whoever does not see that has not grasped the essential import of the notion of creation; he has restricted and anthropomorphised it beyond what is permissible.[32] Once that has been pointed out, moreover, we are at complete liberty to return calmly to the biblical conception of an initial creation after or beyond which is a divine repose.

We henceforth know well that one can conceptualize this repose in any of three forms: as sanctioning the fixity of beings in their genus and species; as giving them over to their progressive unfolding through time; or finally, as imparting to the latent psychism with which it has endowed them the responsibility for temporal creations more and more exuberant.

One is free to choose, awaiting further evidence; but it is to be fervently hoped that after so much vain quarrelling, we Christians will cease bringing forward unjustified censures respecting this doctrine of evolution, to which—under one form

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l'action divine dans l'univers" (1920?), "Comment je vois" (1948), "Les noms de la matière" (1919), "Contingence de l'univers et goût humain de survivre" (1953), are perfectly clear: the First Necessity is definitely envisaged as enveloping simultaneously both God and the 'stuff' presupposed for his action as Creator, which action is envisaged with equal definiteness as consisting exactly in an arrangement starting from a primitive chaos; while as far as any quest for causes is concerned, Teilhard repeats tirelessly that he seeks only "an experimental law of recurrence, not an ontological analysis of causes." (See *The Future of Man* [New York: Harper, 1964], p. 110 fn. 1; *The Phenomenon of Man*, p. 29; *et alibi.*) On all these points relating to Teilhard's metaphysical position as it bears on the problem of creation, see (in addition to "Comment je vois," Teilhard's four-page *ex professo* statement of his general metaphysics) Claude Tresmontant, "Le Père Teilhard de Chardin et la Théologie," in *Lettre*, 49–50 (septembre-octobre, 1962).

[30] *Ibid.*, p. 19.

[31] *Ibid.*, pp. 6–7.

[32] At an earlier point in his study (p. 9), Sertillanges had already appended this important note: "One must understand at this point what our intention is in speaking, as we shall do throughout this work, in the language of what is called anthropomorphism. There is an anthropomorphism of a common order entailed in the very expression of thought. With regard to this anthropomorphism, everyone must make his own adjustments. Those anthropomorphisms which we exclude from our work are first of all a doctrinaire anthropomorphism, which implies a falsification of the divine; and also, in that which concerns the philosophers, a conceptual and verbal anthropomorphism which has little relation to a precise study of problems—especially in the contemporary age."

or another [under the second form, as it has turned out]—the future seems certain to belong.[33]

That future in which Sertillanges so firmly believed has become our present. Where it is a question of thinking men, one can no longer "recognize in each the right (1) to reject the idea of evolution *en bloc* if it pleases him; (2) to choose among the diverse historical forms which it might take; or simply (3) to await solution of the difficulties that it raises and the outcome of the crisis through which the transformism of yesterday is incontestably passing."[34]

With respect to the first point, "Evolution as an historical process is established as thoroughly and completely as science can establish facts of the past witnessed by no human eyes."[35]

With respect to the second point, "there is nothing in the evidence gathered by paleontology and morphology that would warrant the assumption of autogenesis," or, as it is sometimes called, *orthogenesis*,[36] i.e., specific and transpecific evolution resulting from inherent tendencies, vital urges, or cosmic goals pursued by a "latent psychism." "On the contrary, the lack of fixed plan in detail but the tendency to spread and fill whenever possible is exactly such a picture as would result from the impulses of a random opportunism,"[37] from fundamental natural units "given over to their progressive unfolding in time." The ubiquitous irregularity in tempo and mode borne out unmistakably in the fossil record negates the postulation of any overall trend subtending the individual organisms but not adaptive in nature.[38]

[33] *Ibid.*, pp. 142–143.

[34] *Ibid.*, p. 127.

[35] Theodosius Dobzhansky, *Genetics and the Origin of Species* (3rd ed., rev.; New York: Columbia, 1951), p. 11.

[36] Theodosius Dobzhansky, *Mankind Evolving* (New Haven: Yale, 1962), p. 17; see pp. 16–17.

[37] George Gaylord Simpson, *The Meaning of Evolution*, p. 121. "There are two aspects of opportunism: to seize such diverse opportunities as occur, and when a single opportunity or need occurs, to meet it with what is available, even if this is not the best possible." (*Ibid.*, pp. 167–168).

[38] "If 'nature' means the whole material universe, then the hope for scientific understanding becomes very remote. If to understand anything we must understand all, then science is impossible. If however, as is obvious enough, this world is not one single 'nature', but many individuals varied in nature and forming distinct and relatively independent centers of activity, then the problem of scientific understanding is worth tackling. We may hope to arrive at some essential knowledge of this or that kind of thing, even if the whole escapes us. The history of science makes clear that scientific progress requires piecemeal procedures. . . . The strongest objection to the point I have been making is the view of some physicists that the universe is one continuous 'field'. . . . A 'general field theory' [however] would cancel the evidence for the existence of primary natural units only if it could show that all changes form a rigidly deterministic system which could be attributed to one single intrinsic principle, and not to the conflict and balance of many [relatively] independent units. The whole course of modern physics, on the other hand, has been to reaffirm the fact, which is obvious enough at the macroscopic level, that this universe is not rigidly deterministic." (Benedict M. Ashley, "Does Natural Science Attain Nature or Only the Phenomena?" in The *Philosophy of Physics*, ed. by V. E. Smith [Jamaica, New York: St. John's University Press, 1961], pp. 66 and 69, *passim*.) Cf. Yves Simon, *The Tradition of Natural Law* [New York: Fordham, 1965], pp. 55–56; and note 155 below.

With respect to the third point, as recently as a generation ago, among the many evolutionary explanations proposed to account for the almost incredible diversification and complication of living forms now existent, "there seemed so little reason to choose among some of them, so much to say against any one of them, that the non-partisan student could feel only confusion or despair." Today, however, "one theory has emerged"—the variously called synthetic, integrative, neo-Darwinian, or sometimes simply biological theory of evolution—"that is judged superior and, *as far as it yet goes*, virtually irrefutable according to a large consensus."[39]

To borrow an admirable formulation from Mortimer Adler:

> Having an open mind about future possibilities should not be equated, as unfortunately it sometimes is, with having an undecided mind about present actualities; for we are obliged, at any time, to judge in the light of the evidence that is then available.[40]
>
> If the possibility of contrary future evidence were to disbar us from drawing conclusions from the evidence now available, we could never draw any conclusions whatsoever from the data of scientific investigation.[41]

And it is nothing less than the evidence now available which constrains one to acknowledge forthrightly that organic evolution occurs automatically wherever there is interaction of living forms through succeeding generations, and that this evolution is associated in fundamental ways with those inorganic interactions inexorably at work in the formation of the stellar and planetary systems.

C. Evolution as reality and idea

It is impossible to overemphasize the points that have been made above, in differing accents, by Bergson, Nogar, Crespy, and Sertillanges. For if it is true that "the facts upon which philosophy rests are absolutely general, primordial facts, not such facts as are observable only with more-or-less difficulty—and which, as science progresses, become more and

[39] Anne Roe and George Gaylord Simpson, eds., *Behavior and Evolution* (New Haven: Yale, 1958), p. 5. See however Sections IV and VII of J. N. Deely's "The Philosophical Dimensions of the Origin of Species," *The Thomist*, XXXIII (January and April, 1969), Part I, pp. 102–130, and Part II, pp. 290–304, respectively, for an analysis of "how far this theory yet goes."

A clear statement of the main lines of the currently ascendent "synthetic theory" may be found in Part II of this volume at two places: in Section I, The Uniqueness of Man, in the third reading, "The Emergence of Man," by John N. Deely; and in Section III, The Moral Issues, in the third reading, "Man in Evolution," by F. J. Ayala.

[40] Mortimer J. Adler, *The Difference of Man and the Difference It Makes* (New York: Holt, Rinehart, and Winston, 1967), p. 113.

[41] *Ibid.*, p. 122.

more points at which the real coincides with the (always more and more complex and refined) [mathematical] constructions previously set up by scientific reason—but absolutely general and absolutely first facts," keeping always in mind, however, that these absolutely general and primordial facts do not arise out of so-called "vulgar" or "common" experience (since "vulgar experience intervenes in philosophy only as a substitute, when no scientific experience is available");[42] if this be allowed, then it must be acknowledged that the concept of evolution as we have just delineated it, a concept immediately derived from scientific experience with no intervening mathematical construction of which it is but an explanatory image, this concept, by every criteria of judgment and criticism under the proper light of philosophy, has got to be accepted as expressing a *properly philosophical fact.*

This brings us to the fundamental and primary distinction between the *fact* of evolution and the *explanation* of that fact; between the *quod* of evolution, *that which* has taken place, and the *quo* of evolution, that *by which* evolution has taken place, or between the *phenomenology* and the *ontology* of evolution; between the evolutionary *products* and the evolutionary *process*; between in a word, the *concept* and *content* of the idea of evolution; between evolution as *world-view* and as *philosophy*, between the *observations* contributing to the realization of the evolutionary universe, and the *explanations* which bring us toward an understanding of this universe. The former pertains to knowing within the perspective of a simple certitude of fact; the latter pertains to knowing in the perspective of the reason of being, or of explanation. We shall return to this fundamental distinction between the orders of observation and explanation in considering the relation of Darwin's world to the world of classical antiquity.

What is of interest to us for the moment is Dr. Nogar's point that "the explanation of *how* the process of orderly change of successive generations through time has been accomplished must be dissociated from the

[42] See Jacques Maritain, *The Degrees of Knowledge*, "The Proper Conditions for Philosophy. Its Relation to Facts," pp. 57–60. See Sec. III of "The Philosophical Dimensions of the Origin of Species," on "The logic of rational understanding," pp. 93–102; and cf. M. J. Adler, *The Conditions of Philosophy* (New York: Atheneum, 1965), esp. chs. 5–12, pp. 79–230. See also note 114 below. The role of what will be called in this essay "observed facts" or "data" in the empirical sense has, so far as philosophy is concerned, been recently outlined with particular clarity in a posthumous book of Yves Simon, *The Great Dialogue of Nature and Space* (New York: Magi, 1970), pp. 139–179, esp. p. 154: "In all rigor we can say that every essential part of the philosophical edifice is built on facts of common experience . . . not however . . . that every philosophical fact is at the same time a fact of common experience. . . . There are [as in the case of evolution] some philosophical facts which can be established only through the technical elaboration of an experience. On the other hand, we should also note that the majority of vulgar facts are not philosophical facts." For the full details of this summary, the reader is referred to Simon's work.

statement *that* such an orderly succession has taken place."[43] However one wishes to draw this distinction terminologically, the matter at issue is clear, and a point of widespread agreement at the level of historical consciousness attained in our century. It was with this in view that we referred earlier to evolution as the determining problematic for all synthetic thought in our day. It is in this respect (and in this respect alone) that one must accept Teilhard de Chardin's elevation of evolution above the status of a theory, system, or hypothesis to the status of "a general condition to

[43] Raymond J. Nogar, "From the Fact of Evolution to the Philosophy of Evolutionism," *The Thomist*, XXIV (1961), p. 464. The classical position here expressed by Nogar, the position, namely, that observation and explanation are distinct in principle and analytically separable in any given case (and hence that the record of evolutionary unfolding is not tied to any particular explanation of how that unfolding transpired), is the one taken by all or most of those conversant with evolutionary science. This classical view has, however, been recently subjected to attack by a number of philosophers of science whose chief and—significantly (see fn. 132 below)—almost exclusive concern has been the explanatory pattern of modern physics, which we will define shortly as the Platonic Explanatory Mode. Outstanding among these attackers, perhaps, are: (A) T. Kuhn, *The Structure of Scientific Revolutions* (2nd ed., enlarged; Chicago: University of Chicago Press, 1970); "Logic of Discovery or Psychology of Research?" in *Criticism and the Growth of Knowledge*, ed. by I. Lakatos and A. Musgrave (Cambridge: Oxford University Press, 1970), pp. 1–23; "Reflections on my Critics," in *Criticism and the Growth of Knowledge*, pp. 231–278. (B) N. R. Hanson, *Observation and Explanation* (New York: Harper & Row, 1971); *Patterns of Discovery* (Cambridge: Oxford University Press, 1958); *Perception and Discovery*, ed. by W. C. Humphreys (San Francisco: Freeman, Cooper & Co., 1969). (C) P. K. Feyerabend, "Consolations for the Specialist," in *Criticism and the Growth of Knowledge*, pp. 197–230; "How to Be a Good Empiricist: A Plea for Tolerance in Matters Epistemological," in *The Delaware Seminar in Philosophy of Science*, ed. by B. Baumrin (New York: Interscience, 1963), Vol. II, pp. 3–39; "Reply to Criticism," in *Boston Studies in the Philosophy of Science*, ed. by R. S. Cohen and M. W. Wartofsky (New York: Humanities, 1965), Vol. II, pp. 223–261. (D) S. Toulmin, *Foresight and Understanding* (New York: Harper & Row, 1961); "Does the Distinction Between Normal and Revolutionary Science Hold Water?" in *Criticism and the Growth of Knowledge*, pp. 39–48; "Reply," *Synthese*, 18 (1968), pp. 462–463.

In the classical view, it is always possible to provide an identification of facts that is sufficiently neutral to serve as a common measure and test of two opposed theories. The recently developed anti-classical view denies precisely this possibility, and asserts that all observations are theory-laden to such an extent that holders of different theories observe different facts, i.e., what proponents of different theories see in nature is so structured by and dependent upon the theories as to provide no common measure and test. This view, as Landesman points out, derives its inspiration in part from the linguistic fact that "the description and the explanation [of any given phenomenon of nature] may both be formulated in the same vocabulary" ("Introduction" to *The Problem of Universals*, ed. by C. Landesman [New York: Basic Books, 1971], p. 6), and in part from the psychological examples of Gestalt-shifts.

The excess of this recent, anti-classical position that seeks to conflate the distinct orders of observation and explanation has been just as recently shown in a number of ways.

With respect to the particular case of evolutionary science, Michael Ruse has shown the irrelevance of the anti-classical view denying the separability of fact from theory to the historical record of how the Darwinian revolution in biology came about. In other words, Ruse has shown that on the assumption of the truth of the anti-classical position, the actual events surrounding the rise of evolutionary theory become unintelligible. See Ruse, "The Revolution in Biology," *Theoria*, XXXVI (1971), pp. 1–22. R. J. Nogar, on the other hand (in company with such biologists as Dobzhansky and Simpson), has repeatedly shown the relevance of the classical position affirming the separability of fact from theory for coming to terms with the

which all theories, all hypotheses, all systems must bow and which they must satisfy henceforward if they are to be thinkable and true."[44]

But there is no need to put the matter so grandly, and good reason not to: for by evolution are meant products as well as processes; and the discovery of a world in which *nothing is exempt* from change is still not a world in which there is *nothing but* change.

It is therefore much more desirable and philosophically exact to state the point in more measured terms. "There is the theory of evolution," let us say, "and there are theories of evolution. The theory of evolution is the fact—it may surely be called 'fact' in the vernacular—that all organisms that now live or ever lived, all they are and all they do, are the outcome of genetic descent and modification from a remote, simple, unified beginning. Theories of evolution, taking the reality of evolution as given, seek to explain how this almost incredible diversification and complication have come about."[45]

And it is necessary to understand that the root difference between the evolutionary world-view and the world-view of classical or medieval times lies within this very distinction.

II. FROM CLASSICAL ANTIQUITY TO DARWIN'S WORLD

If we pause for a moment in our consideration of the evolutionary concept, and meditate, before passing over to the explanatory dimension of the datum, on the historical emergence of this concept via scientific experience

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Darwinian revolution. In other words, on the assumption of the truth of the classical position, the events leading to the rise of evolutionary science become eminently coherent and intelligible. See Nogar, *The Wisdom of Evolution*, Part I, pp. 27–145.

With respect to the anti-classical position considered in itself, Carl R. Kordig has recently shown that, quite apart from its inability to illuminate particular historical instances of scientific revolutions in the crucial way claimed, the position does not follow from the premises given as its basis, and "leads to unintelligible and absurd consequences." See Kordig, "The Theory-Ladenness of Observation," *The Review of Metaphysics*, XXIV (March, 1971), pp. 448–484; and *The Justification of Scientific Change* (Dordrecht-Holland: D. Reidel, 1971).

The rise of evolutionary theory, indeed, is one of the most eloquent witnesses (as we shall see in these pages) to the fact that, as Kordig insists ("The Theory-Ladenness of Observation," p. 482), "what scientists observe does change," but primarily in the sense that "it increases," and hence forces crucial transitions from less to more comprehensive theories, and even, as we shall argue here, from one to another explanatory mode, in the senses to be defined shortly.

In the terms of the present discussion, the anti-classical view of scientific and intellectual development depends for its force largely on the mistaking of theories as such for world-views, and on a misunderstanding of the role imagination and myths play in linking the two: see fn. 46 and Section III below, "World-View as *Logos* and as *Mythos*," *passim*, but in connection particularly with fns. 168, 181, and 196.

[44] Pierre Teilhard de Chardin, *The Phenomenon of Man* (New York: Harper, 1959), p. 218. See also fn. 1 p. 140.

[45] Roe and Simpson, *Behaviour and Evolution*, p. 5.

as a truly philosophical problematic, we find ourselves confronted with a residuum of factors at play in man's cognitive life which have little to do with logic or evidence, with the general tendency among men to substitute habitual patterns of thinking for evidence, and with the dependence of reason on the testimony of sensation. At the same time, the fact that the evolutionary concept has emerged shows just as definitely that man is able, recurrently and intermittently at least, to function as a scientist, "if being a scientist means asserting as true only those propositions which are based upon sound evidence in a logical manner (i.e., doing non-wishful thinking)."[46] From this point of view, even "rationalization is thus the tribute which emotion pays to reason in order to conceal the latter's deficiencies";[47] and much of the story surrounding the changeover from an essentially static to a radically dynamic world-view concerns little more than the assessment of such tributes.

It is easy, common, and true enough to put forward such statements as the following: "In the eyes of Plato and Aristotle, and in the thought of the West guided by their vision, the universe seemed in its overall duration to be structurally given once and for all. The various kinds of living things seemed to have a fundamental permanence which remained unaffected by the passage of time." Such a statement would, moreover, be perfectly in harmony with the curious inclination on the part of most narrators recounting the intellectual history of the West (particularly where science is concerned) to read dogmatic assertions into ancient

[46] Mortimer J. Adler, *What Man Has Made of Man* (New York: Ungar, 1937), p. 66. In Chapter Three of this book, a discussion of "The History of Psychology" (pp. 61–93), Adler forcefully and clearly demonstrates in what sense and why whatever pertains to the creative genius and psychological condition of the individual, or to his socio-historical conditions, however indispensable for the discovery of certain truths or the arrival at and formulation of certain insights, remains irrelevant to the merits of any intellectual position taken as such. In particular, see his "Digression" on "the error of 'wishful thinking,' sometimes called 'rationalization,'" *ibid.*, pp. 62–64, and his closing remarks on pp. 122–123.

The reasons for this position are not obscure. The proper aim of rational understanding is to assign the reasons for what is given in experience and to gain an understanding of that datum, not to explain it away or indulge in random guessing for the sake of some preconceived theory or personal conviction. "True, a scientist often finds it extremely useful to give his imagination free play in the *preliminary* stages of an investigation, but however brilliant the creations of his fancy they have scientific value only to the degree that they can be reduced to facts." The scientist, and equally the philosopher, in order to avoid excursions into myth-making, "deals only with what he can observe as really existing or something whose existence can be inferred from its observed effects." (Benedict Ashley, "Does Natural Science Attain Nature or Only the Phenomena?" p. 70.) See Section III of Part I of J. N. Deely's article, "The Philosophical Dimensions of the Origin of Species," *The Thomist*, XXXIII (January, 1969), pp. 93–102; and M. J. Adler's discussion of the sense in which philosophy can give us new knowledge of the world that is experienced, which discussion runs throughout his book, *The Conditions of Philosophy* (New York: Atheneum, 1965), but most closely touches on the point just made by Ashley, perhaps, on pp. 144–146.

These observations will be taken up under another aspect in Section III-A of this present essay, "World-view as *Logos*."

[47] David Bidney, *Theoretical Anthropology* (New York: Columbia, 1953), p. 5. See Section III-B of this present essay, "World-view as *Mythos*."

thinkers where only concepts tailored to the available evidences were proffered. The effect is to make modern notions look more decisive and revolutionary than they in fact are.

There are, however, three elements which, from the philosopher's standpoint, must be distinguished in this historical statement. The first concerns the *evidence* on which Plato and Aristotle took their stand; the second and third concern the *account* or *explanation* which they respectively gave for that evidence.

With respect to the question of evidence, we have already noted that any man restricted for the most part to the conceptual horizon of common experiences is bound to acknowledge that a basically unchanging world seems to confront his gaze, not indeed existentially (life does have its ups and downs), but *essentially* or so far as the structures of nature are concerned. Specific stability is a primary datum which the philosopher within this horizon is called upon to elucidate.

A. The platonic explanatory mode

Plato, considering the existential flux and intelligible constancy, located the intelligible constituents in a world beyond the phenomena, a world of transcendent numbers and ideas of which the phenomena are but the changing shadows, "the moving shadow of eternity," as Augustine would later repeat. For the tradition of thought properly called Platonic, the bridge to this ultimate reality is mathematics, to which natural science is subordinated. Such a world of form and number, being of itself incorruptible and eternal, accounts quite neatly for the specific constancies of nature. Inasmuch as the physical world successfully participates in the ideal world, it could only present intelligible constancy; while to the extent that its participation is but participation, and so intrinsically labile, the natural world presents a picture of flux and change. Such, in its essential epistemological type, was Plato's explanation.

Here we are confronted, both historically and philosophically, with the first of the two possible ways, epistemologically speaking, in which the regularities in things noted by means of sensible experience can be accounted for rationally and subsumed within an explanatory scheme. In this type of knowledge which is materially physical but formally (with respect to object and to method of conceptualization) mathematical, the *rule of explanation* prescinds from physical principles and causes with their proper intelligible value. When observations are given an explanation in this form, however, as Simon puts it, "something entirely novel takes place."[48] The very nature of mathematical abstraction renders mathe-

[48] Yves Simon, "Maritain's Philosophy of the Sciences," *The Thomist*, V (1943), p. 101.

matical thought indifferent to the reality of its object, inasmuch as that object can be conceived without sensible matter. Hence, mathematical-physical science tends toward indifference respecting the reality or extramental independence in being of the data it rationalizes. It tends "to make no difference between *ens reale* and *ens rationis*" (i.e., between the sort of being which exists independently of human understanding and the sort of being which is a product of human understanding). What was observed as real is explained as preter-real. "Here the mind escapes into a world of entities which were first grasped in the bodies of nature but immediately purified and reconstructed, and on which other entities, which are indifferently real or 'of reason,' will be endlessly constructed."[49] This world frees us indeed from the sensible, just as Plato contended; but it seems to achieve this rather by sacrificing any order to existence than by putting us in touch with the ultimate reality. "Physico-mathematics is, indeed, a science of the *physical real*, but a science which knows that real only by transposing it, and *not as the physical real*."[50] But if mathematical-physical knowledge "explains" in things only that kind of formal cause which is the conformity of phenomena to mathematical law, on the other hand, just because mechanistic aspects of causality can be retained within the texture of physico-mathematical explanations, this way of rationalizing the evidences compensates for those intelligibly sensible aspects from which it prescinds by enabling us to *predict and control* those aspects of the real from which it does not prescind.[51]

The establishment of a universal science of nature informed by mathematics rather than philosophy has indeed been the great achievement of modern times, based directly on the works of Descartes and Galileo; but the essentials of this method are to be found in much earlier works.

Attribution of the title 'creator of the method of the physical sciences' has given rise to many squabbles; some have wished to give it to Galileo, others to Descartes, still others to Francis Bacon, who died without ever having understood anything about this method. Frankly, the method of the physical sciences was defined by Plato and the Pythagoreans of his day with a clarity and precision that have not been surpassed; it was applied for the first time by Eudoxus when he tried to save the apparent movement of the stars by combining the rotation of homocentric spheres.[52]

[49] Maritain, *The Degrees of Knowledge*, p. 209. Cf. Simon, *The Great Dialogue of Nature and Space*, pp. 89–111, esp. 101ff.

[50] *Ibid.*, fn. 2, p. 42.

[51] One might well raise the question here as to why, if the ancients did indeed grasp the essentials of mathematical-physics, "why did they not push open the door?" Why did technological society not bud forth prior to the sixteenth century? The answers to this question are socio-cultural. In essence, as Farrington among others has shown, it was the cultural denigration of servile work which truncated the development of the technological aspect of science in ancient times: Benjamin Farrington, *Greek Science* (Baltimore: Penguin, 1944), pp. 301, 307–8, 302, and 303.

[52] Pierre Duhem, *Le Système du monde*, new ed.; Paris, 1954, Vol. I, pp. 128–129.

B. The aristotelian explanatory mode

When we turn to Aristotle's account of the fixity of specific structures, we find an attempt at quite another sort of understanding. Aristotle attempted "to construct a natural science which would rest on observation at every point, but which would seek to explain these observations *in terms of their own intelligibility*, not in some a priori or conventional fashion, and which would proceed from general to particular questions *in an orderly but not deductive fashion.*"[53] It would be, not a knowledge of the real by

[53] Benedict M. Ashley, "Aristotle's Sluggish Earth, Part I: The Problematics of the *De caelo*," *The New Scholasticism*, XXXII (January, 1958), p. 8: emphasis supplied. This point is important, but historically confused. The notion of demonstration in the classical Aristotelian tradition "does not insist on a deductive movement from the known to the unknown, but on the knowledge of the proper cause of something expressed by the middle term of a syllogism. In the case of the philosophy of nature the phenomenon is better known to us than its cause, yet demonstration consists in knowing this phenomenon in a special way, namely through its cause." (Benedict M. Ashley, *Are Thomists Selling Science Short?* River Forest, Ill.: Albertus Magnus Lyceum, n.d., pp. 12–13). This is so in view of the fact that to assign the proper causes of some phenomenon is to understand in what kind of subject it inheres (its material and formal cause), and what kind of an agent has produced it and by what steps (its efficient and final cause) (*ibid.*, p. 13); and that "the difference between a descriptive definition and an essential definition . . . is not in the content of the definition but in its order": "we are dealing, therefore, not with an absolute difference between one kind of human knowledge in which is attained a perfectly ordered knowledge of nature (dianoetic intellection) and another which knows nothing of nature except its existence (perinoetic intellection), but rather with a type of intellection proper to man by which he knows at first confusedly and then more clearly as he continues his investigation both the existence of a natural unit and its nature," and the network of interrelations it sustains (Ashley, "Does Natural Science Attain Nature or Only the Phenomena," pp. 77–78; see also pp. 70–75). Consult the key passage in St. Thomas' *Commentary on Aristotle's Posterior Analytics*, Bk. II, Lect. 13, n. 7; and Zigliara's comment on this in the Leonine edition of the works of St. Thomas, tom. I, p. 375 a–b. This view is set out in Section III of Deely, "The Philosophical Dimensions of the Origin of Species," Part I, *The Thomist* XXXIII (January, 1969), pp. 93–102; and developed in a systematic textual study by Melvin A. Glutz, *The Manner of Demonstrating in Natural Philosophy* (River Forest, III.: Aquinas Institute, 1956). Further to this discussion, see fn. 114 below.

Maritain himself, in distinguishing sciences of explanation from "sciences" of observation (*The degrees of Knowledge*, pp. 32–34), restricts explanation properly so-called to purely deductive schema. Since many of the key contentions of biology can claim only a strong inductive support, Maritain would exclude evolutionary theory from the category of explanation. He would regard it simply as a "likely story," or an "empiriological" ("empirioschematic") account. (See *The Degrees of Knowledge*, pp. 64–66 and 192–195.) On precisely similar grounds, T. A. Goudge, in *The Ascent of Life* (Toronto: University of Toronto Press, 1961), has argued that evolutionary science employs a "narrative explanation," i.e., tells only "likely stories" in its account of life, in sharp contrast to the "covering-law explanations" characteristic of physics and chemistry.

For differing reasons, both Maritain and Goudge are mistaken in appealing to the non-deductive aspects of evolutionary theory as ground for drawing a sharp line between two types of "science" or "explanation." Maritain's mistake lies in a failure to realize that, as Ashley has pointed out in the above-cited texts, descriptive definitions do not differ from essential definitions in their cognitive content, but only in their organization of that content. (This matter will be further developed in Section III-A of this essay, "World-view as *logos*".) Goudge's mistake lies in a failure to see that, *if one prescinds from the role mathematics plays*, the explanations of modern physics and biology alike approximate closely, as to an ideal, to the "covering-law model" of explanation, as set forth by Dray (in *Laws and Explanations in*

means of the mathematical preter-real, wherein it becomes increasingly difficult and frequently impossible to differentiate the symbol from the symbolized, but rather "a knowledge whose object, present in all things of corporeal nature, is changeable being as such and the ontological principles which account for its mutability." [54]

With this ideal of science in mind, Aristotle denied Plato's World of Forms by arguing that these incorruptible and eternal essences of things, these invariant structures, are universal natures which exist outside the mind only in things singular and perishable. The immutable types, Aristotle argued, are immanent in the physical world. They are natures which are revealed through the regularities that are observed in the very order of sensible phenomena.

Here we are confronted, historically and philosophically, with the second of the two possible ways in which, epistemologically speaking, the regularities in things noted by means of sensible experience can be accounted for rationally and subsumed within an explanatory scheme. Here, the knowledge is formally as well as materially physical. Its *rule of explanation* is to "reveal to us intelligible necessities immanent in the object," the metalogical existent; to make effects known by principles or *reasons for being*, that is, by causes, "taking this latter term in the quite general sense that the ancients gave to it." [55] It prescinds only from "what in individual cases is never equal—the particular, the contingent, the variable, the unpredictable about specific events—*what is logically incidental.*" [56] When observation is given explanation or reasoned in this form, without any prescinding from the materiality that renders things both perishable and observable, what are revealed to us are intelligible necessities *immanent* in the sensible object, just as in explanations formally

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History [Oxford: Oxford University Press, 1957]), Brodbeck ("Explanation, Prediction, and 'Imperfect' Knowledge," in *Scientific Explanation, Space, and Time*, ed. by H. Feigl and G. Maxwell, Vol. III of *Minnesota Studies in the Philosophy of Science* [Minneapolis: University of Minnesota Press, 1962], pp. 231–272), Hempel (see *Aspects of Scientific Explanation* [New York: Free Press, 1965]), and others, wherein what is to be explained is explained when its sufficient conditions can be stated. This error on Goudge's part is demonstrated by Michael Ruse, "Narrative Explanation and the Theory of Evolution," *Canadian Journal of Philosophy*, I (September, 1971), pp. 59–74.

[54] Maritain, *The Degrees of Knowledge*, p. 176.

[55] *Ibid.*, p. 32. For an indication of the manner in which the rise of evolutionary biology is forcing an expansion and analogization of the narrow, univocal notion of causality as efficient causality which comes down to us in philosophy from Locke, Hume, and Kant, and in science from the suzerainty of mathematical physics since the time of Galileo and Newton, see the analysis in "The Philosophical Dimensions of the Origin of Species," esp. Secs. III, IV, and VII; and the reading selections in this volume by Benedict M. Ashley, "Change and Process," and by C. H. Waddington, "The Shape of Biological Thought," in Section IV *infra*, The Metaphysical Issues.

[56] John Herman Randall, *Aristotle* (New York: Columbia, 1960), p. 184, emphasis supplied. On this question of what is 'logically incidental' about specific events, see Charles De Koninck, "Abstraction From Matter," in *Laval theologique et philosophique*, XIII (1957), pp. 133–197; and Yves Simon, "Chance and Determinism in Philosophy and Science," Ch. X of *The Great Dialogue of Nature and Space*, pp. 181–204.

mathematical what are revealed to us are intelligible necessities *transcendent* to the sensible object as such, and consequently indifferent to its existential status.

Because such a knowledge of nature seeks to understand the things of nature not only from the point of view of quantity or quantified being as such but from the point of view of sensible being, its predictive index is very low. In fact, it is indirect, deriving heuristic value principally "by reason of the stimulations it is capable of giving to the minds of scientists."[57] Because it discloses intelligible reasons immanent in the things of nature as physical, the universality and necessity of this science is predominantly negative, that is, retrospective.[58] The laws it declares express the order of a cause to its effect, to be sure, and in this sense are "eternal" truths, since even when "in the flux of particular events, another cause comes along to interfere with the realization of its effect, that order remains";[59] so that, in the *order of explanation* this science, even as mathematical-physical science, sets before the mind "intelligibles freed from the concrete existence that cloaks them here below, essences delivered from existence in time."[60] (Whereas, by contrast, "the other sciences, sciences of observation, do indeed tend to such truths, but they do not succeed in emerging above existence in time, precisely because they attain intelligible natures only in the signs and substitutes that experience furnishes of them, and therefore in a manner that inevitably depends on existential conditions. Thus, the truths stated by them affirm, indeed, a necessary bond between subject and predicate, but also suppose the very existence of the subject, since the necessity they evince is not seen in itself but remains tangled with existence in time—and to that extent, if I may say so, garbed in contingency."[61])

[57] Maritain, *The Degrees of Knowledge*, pp. 177–178. See G. G. Simpson's essay on "The Historical Factor in Science" in his book, *This View of Life* (New York: Harcourt, 1963), pp. 121–148.

[58] G. G. Simpson remarks: "The testing of hypothetical generalizations or proposed explanations against a historical record has some of the aspects of predictive testing. Here, however, one does not say, 'If so and so holds good, such and such will occur,' but, 'if so and so has held good, such and such must have occurred.' (Again I think that the difference in tense is logically significant and that a parity principle is not applicable.)" *This View of Life*, p. 144.

[59] Maritain, *The Degrees of Knowledge*, pp. 28–29. G. G. Simpson explains this same point in *This View of Life*, pp. 125–127.

[60] *Ibid.*, p. 33.

[61] *Ibid.*, pp. 33–34. On p. 34, Maritain expresses the distinction between what I have called the order of observation over against the order of explanation in the following terms: "it is plain that sciences of the second category, sciences of observation . . . since they are less perfectly sciences and do not succeed in realizing the perfect type of scientific knowledge, are not sufficient unto themselves. Of their very nature, they tend to sciences of the first category, to sciences of explanation properly so called. . . . They are necessarily attracted to them. In virtue of their very nature as sciences, they invincibly tend to rationalize themselves, to become more perfectly explanatory . . . and to that extent they are subject to the regulation of . . . either philosophy or mathematics," i.e., to formulation and expression in either the Aristotelian or the Platonic explanatory mode. (See however the qualifications placed on Maritain's use of this distinction, in fn. 53 above.) Cf. Simpson, *This View of Life*, pp. 125–127, 143–144.

Nevertheless, the "eternal truths" of the natural physicist have a thoroughly *negative* character, that is, their empirical content consists purely and simply in *what they forbid*, just because they are pure objects of understanding and not objects of sensible apprehension or imaginative representation, are, in short, "unimaginable by nature."[62] This is indeed why this natural or philosophical (as contrasted with the mathematical-physical) mode of explanation has no direct heuristic value.

Among the evolutionists, none have grasped these points more clearly than Simpson:

> The search for historical laws is, I maintain, mistaken in principle. Laws apply, in the dictionary definition, "under the same conditions," or in my amendment "to the extent that factors affecting the relationship are explicit in the law," or in common parlance "other things being equal." But in a history, a sequence of real, individual events, other things never are equal. Historical events, whether in the history of the earth, the history of life, or recorded human history, are determined by the immanent characteristics of the universe acting on and within particular configurations, and never by either the immanent or the configurational alone.[63]

On the other hand, the "eternal truths" of the mathematical physicist (i.e., axioms which are neither assessable by reference to motion or that kind of time which is motion's measure, nor false within every known —-thematical system), just because they are objects capable, either ectly or indirectly, of imaginative representation,[64] and are not pure jects of understanding or objects of sensible apprehension—these ths have a *positive*, prospective, or predictive character so far as the rld of natural things is concerned.[65] For whatever exists in a material

1 the ontological explanation typical of philosophy of nature, "being is still considered in order of sensible and observable data. But the mind enters that order in the search of their mate nature and intelligible reasons. That is why, in following this path, it arrives at ions like corporeal substance, quality, operative potency, material or formal cause," *ural selection* (see the references in fn. 107 below and fn. 59 above), "etc.—notions which, ile they bear reference to the observable world, do not, designate objects which are themves representable to the senses and expressible in an image or a spatio-temporal scheme. ch objects are not defined by observations or measurements to be effected in a given way." *'e Degrees of Knowledge*, pp. 147–148). See fn. 65 *infra* for the sense of the expression "what 'y forbid" for the present context.

3. G. Simpson, *This View of Life*, p. 128. See fn. 155 below.

nasmuch as, on the one hand, so far as the basis of arithmetic is concerned, discrete quantity lirectly constructible in imaginative intuition (simply represent two unities); while, on the ıer hand, so far as the basis of geometry is concerned, continuous quantity is likewise directly ıstructible. And these two sciences of discrete and continuous non-physical quantity ıpectively, are the point of departure for the whole of mathematics. See J. Maritain, *The grees of Knowledge*, pp. 35 fn. 3, 140–146, and 165–173; Y. Simon, "The Nature and Process Mathematical Abstraction," *The Thomist*, XXXIX (April, 1965), pp. 117–139; and Philip Davis' article, "Number," *Scientific American*, 211 (September, 1964), pp. 50–59.

It is true, as Karl Popper has pointed out (cf. *The Logic of Scientific Discovery*, New York: ısic Books, 1959, p. 41), that there is a sense in which the empirical content of *every* physical eory, be it mathematical or physical, "consists in what it forbids." When one wishes to ıderstand how the mathematical differs from the natural physical explanation or theory,

way has extension, including qualities; and that is all that is necessary in order that a formally mathematical law hold for any given thing, regardless of its existential state or "particular configuration," as Simpson would say. Because the properties of any given mathematical essence are not really distinct from it,[66] in this mode of explanation, just as there is no question of causal sequence, so also there is no room for chance interventions.[67]

C. Contrasts

It is necessary to insist on this distinction based on the predominantly retrospective and the predominantly prospective characters, respectively, of physical explanations formulated in the philosophical or the mathematical mode if we are to appreciate the full import of the difference

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why a heuristic value attaches essentially to the former and only incidentally to the latter, however, it is not helpful to use an analogous formula without making explicit the difference in meaning which obtains in each case.

The point I am making, then, depends simply on the fact that whatever might be said of the physical world in the philosophical mode of explanation virtually contains whatever might in principle be said in the physico-mathematical mode, but not vice-versa. Curiously, one of the clearest and most straightforward statements of the ontological reasons for this fact may be found in Thomas Aquinas, *In libros Aristotelis de caelo et mundo expositio*, Book I, lect. 3, n. 24; and again in Book III, lect. 3, n. 560. See Deely, "The Philosophical Dimensions of the Origin of Species," Part II, Sect. VII, pp. 290–298 and fn. 220a. As Simpson puts it (*This View of Life*, Ch. 7, "The Historical Factor in Science," pp. 121–148): "Prediction is inferring results from causes. Historical science is largely involved with quite the opposite: inferring causes (of course *including causal configurations*) from results" (p. 146: emphasis supplied). For this reason, "it cannot be assumed and indeed will be found untrue that parity of explanation and prediction is valid in historical science" (p. 137). "With considerable oversimplification it might be said that historical science is mainly postdictive [what I have termed "retrospective"]," and non-historical science mainly predictive [or "prospective"]," with the asymmetry in their logical (and epistemological) types deriving from the fact that in the former instance "the antecedent occurrence [the anticipated discovery] is not always a *necessary* consequence of any fact, principle, hypothesis, theory, law, or postulate advanced before the postdiction was made" (p. 147). See fn. 170 below.

[66] "Nature, in the physics of Aristotle, signifies entity, essence, whatness, quiddity with a constitutional relation to action, operation, movement, growth, development. A nature is a way of being which does not possess its state of accomplishment instantly but is designed to reach it through a progression. (*Phys.* 2.1. 192b, *Met.* 5.4. 1014b.) . . . The formalist majority and the intuitionist minority in modern mathematics would agree that a mathematical object, whatever it may be, is not a nature in the sense defined above, and that, whereas we may call it, if we please, essence, whatness, quiddity, etc., we may not attribute to it a dynamism, a tendency to forge its way in the world of becoming. It does not grow; it is what it is by definition, by construction, instantly; it is possessed of its proper condition of accomplishment immediately and does not have to acquire it by growth." (Yves Simon, *The Tradition of Natural Law*, pp. 43–44).

[67] These remarks make clear how different the notion of determinism in nature will be from the standpoint of the mathematical physicist and from the standpoint of the natural or philosophical physicist. See Yves Simon, "Maritain's Philosophy of the Sciences," pp. 98–99. (For the bearing of this distinction on the question of human freedom, see Simon, *loc. cit.*; and Maritain, *The Degrees of Knowledge*, pp. 186–192, esp. p. 191.) See further fn. 73 below.

between the epistemological type, degree, or kind of knowing exhibited in Aristotle's approach to understanding the given, as opposed to Plato's.

The objects given in experience are certainly particular and contingent; scientific knowledge, as distinct from opinion, certainly bears on the universal and the necessary. It is true that it was this paradox which induced Plato, meditating the fact of certain knowledge, to set up a world of Divine Ideas to which mathematics is the bridge, since *as* ideas the forms of the universe, separate, eternal, and perfect, were necessary and their properties could be known accordingly through the certitude and precision of mathematics. It is also true that Aristotle followed Plato in teaching that there is science, simply speaking, only of the incorruptible and eternal.

But the incorruptible and eternal, the universal and the necessary, are such as *things* only so long as they *transcend* the physical world. Once they are regarded as essences *immanent* to that world, they cease to be *that which* exists (*id quod existit*) to become rather principles *by which* (*principia quo*) things are. In these terms, the whole dispute between Plato and Aristotle turns on the judgment as to whether forms are to be regarded as *things* or as *principles* of things. In the former case, the fixity and immutability of species would be a positive eternity: a given species would either be as it is or not be; in the latter case, the fixity and immutability of species would (in principle at least[68]) be a merely negative one, a condition attaching to specific structures once understood *as understood*. On the part of the things understood *as things*, there could be no question of an actual, i.e., positive, immutability of form as such.[69]

[68] "As far back as the twelfth century, the temptation of fixing natural forms with a stability they do not have was warned against. Many philosophers, in commenting on Aristotle's *Physics*, attempted to make the term nature a *nomen absolutum*, an absolute concept. Thomas Aquinas (1225–74) corrected this interpretation of Aristotle's notion by pointing out that nature is composed of both matter and form and *nature is as much the potential as the actual attributes* of a natural body. Nature is a principle, that is to say, a relation of the generator to the generated, and *cosmic natures are no more fixed than this relation.* True to the Aristotelian principle that there is no other way to know how fixed this relation is than to observe nature, Aquinas and his students repudiated, in theory, the Platonic tendency to identify temporal natures with eternal essences (see esp. Aquinas' *In II Phys.*).

"There was one difficulty. The science of cosmic prehistory was not yet in existence. . . .

"Prior to 1800, the world of nature seemed to reveal only the permanent side of her regularity. Then, the dynamic history of nature—how change, even of species, entered into natural development of the cosmos—was only a faint suggestion on the horizons of science. Consequently, it is not strange that natural philosophers and scientists of the greater period of history have tended to view the cosmos as having ageless or eternal qualities. . . .

"But the most realistic natural philosophers followed the principle that nature was not something absolutely fixed, but rather a relationship between the generator and generated having both perdurance and fluidity. They incorporated the limits of natural permanence *in their theory.*" Raymond J. Nogar, *The Wisdom of Evolution* (New York: Doubleday, 1963), pp. 318–319.

[69] See *The Material Logic of John of St. Thomas*, trans. by Yves R. Simon, John J. Glanville, and G. Donald Hollenhorst (Chicago: University of Chicago Press, 1955), esp. Ch. II.

It is just this point which seems to go unaccounted for in Jonas' opinion that "the liquida-

Thus it is simply erroneous to contend that the contemporary vision of species "as a concretion of history, our belief that kinds are only snail-slow rhythms in a world forever in change, would be for Aristotle a betrayal of the very spirit of knowledge, of mind and the real."[70] For, in order to understand the contemporary vision and to contrast it with that of the ancients, "it is not, to be sure, a question of giving up that [ordinary] logic," which Aristotle systematized for the first time, "or of revolting against it."[71] It is simply a question of considering carefully the distinction between the possible and the real, in order to "see that 'possibility' signifies two entirely different things and that most of the time we waver between them, involuntarily playing upon the meaning of the word."[72] And in grasping the three terms (not two) involved in the possible/real distinction, one grasps as well the sense in which the ancients asserted—and were right in asserting—that scientific knowledge is indifferent to the singular—not absolutely, but only with respect to the negative sense of "the possible."[73]

Hamlet was doubtless possible before being realized, if that means that there was no insurmountable obstacle to its realization. In the particular sense one calls possible what is not impossible; and it stands to reason that this non-impossibility of a thing is the condition of its realization. But the possible thus understood is in no degree virtual, something ideally pre-existent. . . . Nevertheless, from the quite negative sense of the term 'impossible' one passes surreptitiously, unconsciously, to the positive sense. Possibility signified 'absence of hindrance' a moment ago: now you make of it a 'pre-existence under the form of an idea,' which is quite another thing. In the first meaning of the word it was a truism to say that the possibility of a thing precedes its reality: by that you meant simply that obstacles, having been sur-

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tion of immutable essences . . . signifies the final victory of nominalism over realism." (Hans Jonas, *The Phenomenon of Life*, New York: Harper, 1966, p. 45). See "The Philosophical Dimensions of the Origin of Species," Part II, esp. Sections VI and VIII, in *The Thomist*, XXXIII (April, 1969), pp. 251–290 and 305–331, respectively.

[70] Marjorie Grene, *A Portrait of Aristotle* (Chicago, 1963), p. 137.

[71] Henri Bergson, *The Creative Mind*, trans. by Mabelle L. Andison (New York: Philosophical Library, 1946), p. 26.

[72] *Ibid.*, p. 21.

[73] The notion that perfectly scientific, i.e., universal and necessary, knowledge of the singular as such is possible depends on the view that whatever happens in the natural world happens of necessity. This error, as we have noted above (in fn. 67), springs principally from a false conception of the nature of causal determinism. "In the first place, it is not true that if any cause whatever is present its effect necessarily follows, for there are causal actions which do not necessarily achieve what they tend to effect, but . . . in a particular instance may be robbed of their efficacy by the conflicting influence of some other cause(s). . . . In the second place, every individual substance (omne quod est per se), that is, everything that constitutes an essence in the sense of an individual existent or is in the strict sense a being, has a cause; but that which is by accident has *as such* no cause, inasmuch as, not being truly one, it is not truly being." (Thomas Aquinas, *Summa*, I, q. 115, art. 6.) Further to this point, see fn. 38 above and fn. 155 below. The best general discussion of this topic I have come across is Yves Simon's analysis of "Chance and Determinism in Philosophy and Science," in *The Great Dialogue of Nature and Space*, pp. 181–205.

mounted, were surmountable. But in the second meaning it is an absurdity, for it is clear that a mind in which the *Hamlet* of Shakespeare had taken shape in the form of possible would by that fact have created its reality: it would thus have been Shakespeare himself.[74]

We are speaking of man's understanding of the world; it is a question of human knowledge, therefore; and since, within the framework of Aristotelian metaphysics and psychology, "reality is not referred to knowledge but the reverse,"[75] there can be no question that "the truth of those things which do not always stand in the same relation to being is not unaffected by change," for "as a thing stands with regard to being, so does it stand with regard to truth."[76] So far as human insight is concerned, "the thing and the idea of the thing" are "created at one stroke when a truly new form [was not every individual form, taken as such, though not specifically, unique—"truly new"—in the philosophy of Aristotle?] invented by art or nature is concerned."[77] One need only avoid unconsciously playing on the positive and negative senses of the word possible in assessing the evolutionary data, adhering the while to the most rigorous logic, if one wishes to understand the evolutionary as opposed to the static world-view; for what is decisive in any philosophy for which essences are *principia quo*, principles by which things are, is not the *eidos*, the Idea of the world, but the realization that "actions have to do with singular things and all processes of generation belong to singular things,"[78] because this implies that "universals are generated only accidentally when singular things are generated,"[79] so that it is necessary to say that natural process "creates, as it goes on, not only the forms of life, but the ideas that will enable the intellect to understand it, the terms which will serve to express it."[80]

Dr. Nogar has, I think, brought this point out (so far as it involves an issue at once historical and philosophical) better than anyone else. After examining all the various uses to which Aristotle put the term "nature" and discriminating among these which was the basic usage so far as Aristotle's own explanations of observed data are concerned, Dr. Nogar was able to remark:

> Some of Aristotle's commentators attempted to make nature a thing intrinsically generated by which the progeny was organized and exercised its energies. For them,

[74] Bergson, *The Creative Mind*, p. 102.
[75] Thomas Aquinas, *In duodecim libros metaphysicorum Aristotelis expositio*, Bk. V, lect. 9, n. 896 (see also n. 895).
[76] *Ibid.*, Bk. II, lect. 2, n. 298.
[77] Bergson, *The Creative Mind*, p. 22.
[78] Aquinas, *In I Met.*, lect. 1, n. 21.
[79] *Ibid.*, Bk. VII, lect. 7, n. 1422.
[80] Bergson, *Creative Evolution*, p. 114. I am quite well aware that in having contextualized him thus I have given what Maritain has called the "Bergsonism of intention" precedence over the "Bergsonism of fact."

nature became an object like a motor in a car. Aristotle insisted upon the *relative* meaning of the concept: it signified the determined relationship of the generator and the generated by which the thing generated received its characteristic organization and activity, whether living or not. By inferential steps from inheritance in the wide sense of any cosmic natural generation, Aristotle formulated his physical definition of nature. *Nature is the spontaneous source and cause of activity and passivity endowed by the generator upon the natural entity generated, intrinsically determining its fundamental characteristics and attributes both structural and functional.* Nature, then, as a principle and cause of characteristic activity and receptivity received from the generator, is an empirical coordinate concept, that is to say, one based upon the investigation of the constant, stable, typical, and unique relation set up by the generator's self-replication.[81]

In short, once Aristotle made Plato's transcendent forms into universal natures existing outside the mind only in things singular and perishable, natural species could no longer be regarded as eternal and immutable (on the side of the things themselves) for epistemological reasons. Once immanent, natural species could be "no more and no less permanent, stable, unique, and constant than the relation of generator-generated manifested under the closest scrutiny."[82] Henceforward, so long as a thinker wished to remain within the order of a natural philosophical assignation of reasons for being, "a mathematical or metaphysical conception of essence as an absolutely fixed and eternal idea cannot be superimposed upon natural bodies, except in the sense of an ideal type, and one must be careful here not to drift into the idealism of Plato and imagine that the real horse is the idea, and the domestic horse but a shadow of reality. As an archetype or idea, the horse can be conceived of as free of the ravages of time, but the natural history of the horse family shows it to be about 60 million years old with an estimated evolutionary rate of 0.15 genera per million years."[83]

[81] Raymond J. Nogar, "Evolution: Scientific and Philosophical Dimensions," in *Philosophy of Biology*, ed. by V. E. Smith (New York: St. John's University Press, 1962), pp. 57–58. "Nature, therefore, as the relative relation of the generator to the generated, the parent to the progeny in organic beings, is *dynamic* and *changing*, and must be conceived as of the temporal order. It is important that the permanence and stability of natural bodies be acknowledged, for regularity, unicity, and type are evident. But the permanence and stability, even of species, is no greater than the stability of the relation of the generator to the generated." (Nogar, *The Wisdom of Evolution*, p. 319). For the sort of qualifications that would have to be appended here to complete this analysis, see John N. Deely, "The Philosophical Dimensions of the Origin of Species," esp. Secs. VIII and IX, in *The Thomist*, XXXIII (April, 1969), pp. 305–335.

[82] *Ibid.*, p. 59.

[83] R. J. Nogar, *The Wisdom of Evolution*, p. 319. Similarly, "the cat is not eternal, except in the mind of the one who conceives the cat in a set, ordered complex of characteristics. The species, even as it is maintaining itself in existence, is realizing its virtualities and potentialities. It is undergoing mutations which, in turn, effect changes in the materials of heredity. The cat family has proliferated many new species, some of which have become extinct." (*Ibid.*, p. 334). Cf. Martin Heidegger's analysis of "The Limitation of Being," Part IV of his *An Introduction to Metaphysics*, trans. by Ralph Manheim (New Haven: Yale, 1959), esp. "Being and the Ought," pp. 196–199.

That is why—in accord with the requirements of the type of explanation Aristotle essayed—in seeking to understand why Aristotle regarded the specific types of things as given once and for all and why he did in fact attribute positive eternity to species, we must turn not to his metaphysics of knowledge, but to the observations to which he sought to assign reasons for being.

D. Aristotle's eternal species

In the first place we must observe that not only does like beget like, which Eiseley rightly designates "the first fact in our experience,"[84] but that within the world of experience open to Aristotle *not everything exhibited itself as subject to radical transformation.*

Everything which exists on earth, in the "sphere below the moon," experience showed to be subject to generation and corruption; but beyond this sublunary sphere experience seemed to attest to a quite different state of things. "The reason why the primary body," i.e., the heavens, "is eternal and not subject to increase or diminution, but unaging and unalterable and unmodified, will be clear from what has been said," said (as Aristotle has already reminded his readers at the opening of the chapter of the *Treatise on the Heavens* from which this quote is taken) "in part by way of assumption and in part by way of proof." Moreover, and what is decisive for the type of natural science Aristotle has undertaken to realize, "our theory seems to confirm experience," direct experience, not merely mathematically rationalizable experience, "and be confirmed by it."[85]

> The truth of it is also clear from the evidence of the senses, enough at least to warrant the assent of human faith. *For in the whole range of time past, so far as our inherited records reach, no change appears to have taken place either in the whole scheme of the outermost heaven or in any of its proper parts.* The common name, too, which has been handed down from our distant ancestors even to our own day, seems to show that they conceived of it in the fashion which we have been expressing. . . . And so, *implying that the primary body is something else beyond earth, fire, air, and water* [i.e., something else beyond the types of matter which we find in the sublunary sphere], they gave the highest place a name of its own, *aeither*, derived from the fact that it 'runs always' for an eternity of time.[86]

We are here at the heart of the matter. So far as the thinking of Aristotle guided the thought of antiquity and medieval times, it was this

[84] Loren Eiseley, *Darwin's Century* (London: Scientific Book Guild, 1958), p. 208.
[85] Aristotle, *De Caelo*, Book I, ch. 3, 270b1–5. J. L. Stocks' translation in *The Basic Works of Aristotle*, Richard McKeon, ed. (New York: Random House, 1941), p. 402.
[86] *Ibid.*, 270b 1–25, p. 403 (here I have departed from Stocks' translation slightly), my emphases.

notion of the eternal heavens which provided a seemingly ontological and not merely epistemological *ratio* for the fixity of species. Hence it is not correct to say that, within the framework of Aristotelian metaphysics and psychology, it was the theory of scientific knowledge which required the positive fixity of species. Within that framework, this assertion of Marjorie Grene has been shown to be mistaken. Most fundamentally it was the enculturated conception of the eternal heavens which deflected even the most penetrating of the classical and medieval analyses of the ontological character of essential structures.

For Aristotle and St. Thomas, it was the eternal space-time of the changeless celestial spheres which determined the place and order of sublunary bodies; and so founded the rigid necessity and formal immutability of their natures. The Aristotelian essences of material beings, including those of living organisms, did not have their cosmological (or ecological) reference to what is understood today by the physical environment. That reference was rather to the unchanging heavens which, as instruments of the separated intelligences (identified in some, though not all, schools of medieval theology as the angels of revelation[87]) were regarded as the *universalis regitiva virtus generationum et corruptionum*, the governing power regulating the interactions of the terrestrial world of natures. But this physical image of the universe—a physical image, moreover, which survived into Galilean times—originally was constructed in the mathematical rather than the philosophical mode of explanation by Eudoxus (later Ptolemy) and other astronomers of the Platonic school. Later transposed with insufficient critical care ("in part by way of assumption, in part by way of experience," as Aristotle said) into a tendentially ontological explanatory framework, it became the principal factor determining first Aristotle's and later Aquinas' attitude toward the fixity of species, and especially of biological species. For example, in Aquinas' *Commentary* on the third book of Aristotle's *Metaphysics*, we find these remarks:

> . . . the Philosopher shows that the first active or moving principles of all things are the same, but in relation to a certain order of rank. For first indeed are the principles without qualification incorruptible and immobile [to wit, the separated intelligences]. There are however, following on these, the incorruptible and mobile principles, to wit, the heavenly bodies, which by their motion cause generation and corruption in the world.[88]

[87] See James A. Weisheipl's study, "The Celestial Movers in Medieval Physics," in *The Dignity of Science*, edited by James A. Weisheipl, D.Phil. [Oxon.], (Washington, 1961), pp. 150–190.

[88] *In III Met.*, lect. 11, n. 487. See Aristotle, *Metaphysics*, Bk. XII, 1073a14–1073b17, for the "demonstration" referred to, and Aquinas *Commentary*, Bk. XII, lect. 9, "The Number of Primary Movers." (See Maritain's critical note in this regard in *The Degrees of Knowledge*, p. 224 fn. 1.)

Similarly, in commenting on the seventh book in connection with the key problem of the possible origin of living from non-living matter, what the ancients referred to as "spontaneous generation" and what we today call "biopoesis," reference is again made "to the power of the heavens, which is the universal regulating power of generations and corruptions in earthly bodies. . . ."[89]

This state of affairs in the world-view of classical antiquity, as Jacques Maritain has taken such care to manifest, is not without irony. Plato had perceived in a very clear fashion the proper method and intrinsic requirements of the mathematical mode of reasoning about nature. "In virtue of an admirable intuition of the proper conditions of physico-mathematical knowledge and of what are called the exact sciences, when ceasing to be purely mathematical, they undertake to explain the world of experience,"[90] Plato saw clearly that the creation of scientific myths is a necessary consequence of the explanatory mode of the mathematical physicist. For in physico-mathematical formulae it is impossible to differentiate the symbolized from the symbol—what belongs to the real as reasoned from what belongs to the pre- or extra-mental consistency of reality, the real as such or as real.

Aristotle, however, set about a typically different task, a task different according to its epistemological mode and type, I mean; a task the possibility of which Plato had not seen. "He founded the philosophy of sensible nature. And to do that he had to attack the Platonic metaphysics and the theory of Ideas."[91] But although Aristotle acknowledged the existence of a knowledge of nature mathematical in mode, he seems not to have grasped clearly the consequences of employing its method, however instrumentally; so that, on the one hand, although in his astronomical theory of homocentric spheres, he had himself constructed a first-rate mathematical-physical myth, on the other hand "he seems to have accorded to these spheres a full ontological value, a reality not only fundamental (as to their foundation in the nature of things) but formal and entire (as to their formality, to their thinkable constituent itself.)"[92] Accepting as the basis of his treatise *De Caelo* the universe of concentric spheres with axes at

[89] Aquinas, *In VII Met.*, lect. 6, n. 1403. See also nn. 1400–1401. For the contemporary state of the question concerning the problem of the origin of life in the evolutionary process, see J. N. Deely, "The Philosophical Dimensions of the Origin of Species," Part II, *The Thomist*, XXXIII (April, 1969), pp. 321–325, and references therein cited. L. Henderson's *The Fitness of the Environment*, "An Inquiry into the Biological Significance of the Properties of Matter" (Boston: Beacon Press Paperback, 1958), remains a classic statement of the wider context of this problem; while the historical development and permutations of thought on the issue can be found in any good history of the life sciences—e.g., E. Nordenskiold, *The History of Biology* (New York: Tudor, 1935); C. Singer, *The Story of Living Things* (New York: Harper, 1931).

[90] Maritain, *The Degrees of Knowledge*, p. 162.

[91] *Ibid.*, pp. 162–163.

[92] *Ibid.*, p. 163.

diverse angles in relation to one another postulated by the mathematicians, Aristotle attempted to supply the physical explanation of this mathematical diagram. "Because the point of view of the philosopher of nature predominated in him he did not see as well as Plato did the aspect of ideality necessarily embodied in the mathematical knowledge of the phenomena of nature precisely as exact science";[93] and to this oversight, coupled with Aristotle's careful observation of the reproductive pattern of living things and near-complete ignorance (*nescience*, to speak formally) of the fossil record, we owe the attitude and opinion of classical antiquity, so far as it was shaped by Aristotelian writings, on the fixity of species.

E. The fixity of species in medieval and early modern times

Within this classical tradition, the fact that the basis for opinion on the fixity of species derived from a crossing of two epistemological types, two diverse explanatory modes, seems to have raised no doubt so far as the general physical image of the universe was concerned. Nor was there any particular reason why it should have, so long as such arguments for the stationary earth as that from stellar parallax remained as the only arguments accounting for the then known evidences, "for we are obliged, at any time, to judge in the light of the evidence that is then available." Nevertheless, the "crossing" of the two explanatory modes from which the physical image in question sprang did not itself go unnoticed:

> In seeking to provide an explanation for some datum, reason can be employed in either of two ways. In the first place, it can be so employed as to establish sufficiently the reasons for the fact, as in philosophy (*in scientia naturali*) there seem to be reasons sufficient for demonstrating that the movement of the heavens is of a uniform velocity [here we see the physical image of Aristotle's universe maintained]; but reason can also be employed in another fashion which does not establish the reasons for the fact, but which rather shows that explanatory reasons proposed in advance are congruous with the fact to be understood, as instanced for example in astronomy, where the theory of eccentrics and epicycles is proposed for the simple reason that the sensible appearances of the heavenly movements can thereby be saved. This latter type of explanation cannot suffice to prove anything, however, for it may well be that [as Copernicus, Galileo, and later Newton, to be followed first by Einstein and then by . . . ? would amply demonstrate] these appearances could be equally well saved within the framework of other theories.[94]

[93] *Ibid.*

[94] Thomas Aquinas, *Summa*, I, q. 32, art. 1 ad 2. In lect. 17 of his *Commentary* on the second book of Aristotle's *De Caelo (Treatise on the Heavens)*, n. 451, Aquinas, tracing the attempts made first by Eudoxus and subsequently by various others to account for the occasional shifts in the velocity of the planets, summarizes with this observation: "The suppositions proposed by none of these men are necessarily true: for although by granting such suppositions the appearances would be saved, it still is not necessary to say that they are true supposi-

Nor did the possible insufficiency of the evidence leading to the view of species as fixed go unremarked. Commenting on Aristotle's conclusion that the heavens are unalterable, Aquinas is careful to point out that although this view is based on the long experience and common estimation of men, nonetheless, it is a view formed concerning matters which men are able to observe only "at intervals and from a great distance." Consequently, the immutability of the heavens (upon which, it will be remembered, the eternity of species was predicated) is "a view which can only be considered probable, not certain."

> For the longer-lived anything is, the more time is required for its changes to be manifest, as for example there can be changes in a man over the course of two or three years which will not be evident, whereas similar changes in a dog, or any other animal having a more rapid metabolism than man, would be readily observable within such an interval. One could argue accordingly that although the heavens are subject to transformation, the processes of change within them are of such a scale that the entire span of recorded history is not yet sufficient for making them manifest to us.[95]

There is no doubt that all this was neglected by the self-styled Aristotelians of the seventeenth and eighteenth centuries. So easily does habit substitute itself for evidence in human reasonings that, for most of them, what Marjorie Grene says of Aristotle himself holds good. So far as their understanding went, "the round of nature imitates the round of the celestial spheres: so that while father generates son and not son father, man generates man [camels are camels are camels, Nogar delighted to say, summarizing their essential world-view], eternally. Only the fixity of each ontogenic pattern through the eternity of species makes Aristotelian nature and Aristotelian knowledge possible."[96] It must be said, however, that Miss

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tions, because it is possible that the appearances could be saved with respect to the stars and planets according to some other explanatory scheme *not yet conceived of by men. Notwithstanding, Aristotle employed suppositions of the above mentioned sort as though they were true* so far as the character of the celestial motions is concerned." Is what Aristotle did in this case so different from what contemporary mathematical-physicists undertake? Cf. A. Einstein and L. Infeld, *The Evolution of Physics* (New York: Simon and Schuster, 1950).

[95] Aquinas, *In I de caelo*, lect. 7, n. 77. For a textual analysis of the conceptual function of the celestial bodies in the thought of classical antiquity, see Thomas Litt, *Les corps célestes dans l'univers de saint Thomas d'Aquin* (Paris: Nauwelaerts, 1963). For an analysis of the theoretical implications of the removal of this function, see John Deely, "The Philosophical Dimensions of the Origin of Species," Parts I and II, *The Thomist*, XXXIII (January and April, 1969), pp. 75–149 and 251–342, respectively; and the reading selection by Benedict Ashley, "Change and Process," which appears as the second reading in Part II, Section IV of this volume, The Metaphysical Issues.

[96] Marjorie Grene, *A Portrait of Aristotle*, p. 137. See fn. 68 above; also Maritain, "The Conflict of Methods at the End of the Middle Ages," *The Thomist*, III (October, 1941), pp. 531–533; and Ashley, "Aristotle's Sluggish Earth, Part II: Media of Demonstration," *The New Scholasticism*, XXXII (April, 1958), "Conclusion," pp. 230–234; and the references in fn. 95 above.

Grene's treatment of Aristotle himself here is wide of the mark. We may summarize this whole issue by passing on the judgment of Maritain, which is the only one that will bear the weight of the evidence we have adduced: "Despite what certain popularizers may say (and even those thinkers who attribute to the ancients their own carelessness in distinguishing the intelligible from the topographical, and metaphysics from astronomy), these charges do not stand up in the case of the philosophy of Aristotle when carried back to its authentic principles."[97] "And it is fascinating to speculate how," J. H. Randall is quick to add, "had it been possible in the seventeenth century to reconstruct rather than abandon Aristotle, we might have been saved several centuries of gross confusion and error."[98]

Such "reconstruction," however, actually amounts to no more than a clear recognition of the two typically distinct ways in which reason can function in seeking to explain our experience of natural phenomena, with an equally clear appreciation of the power and limits of each of these epistemological types.

What is really new in the achievements of the science which became predominant in the 16th and 17th centuries, of "modern science," is properly speaking a physics of the physico-mathematical type. (In other scientific domains which are not thus absorbed by mathematics, modern science doubtless owes its material or technical perfection, and an autonomous conceptual lexicon which permits infinite progress in the analysis of phenomena as such, to the attraction exerted by physico-mathematics on the other kinds of knowledge, which henceforth see in the former the exemplar of knowledge.)

In truth, the epistemological principles of the Ancients considered in their very nature could easily have adapted themselves to the new physics; the logical type to which that science corresponds, and of which *astronomy* was the best example during antiquity, theoretically had its place set down in the Scholastic synthesis of sciences. This logical type is that of a science in a sense intermediary between Mathematics and Physics, but actually *mathematical* as regards its typical mode of explanation, since what is *formal* and consequently specifying in it (its formal object and its medium of demonstration) is mathematical. The explanatory deduction is mathematical. Physical reality, although of prime importance to it as subject-matter, is basically, for it, a material reservoir of facts and verifications. And thus, while natural philosophy may be characterized as a physical knowledge properly philosophical and ontological, or metaphysical by participation,[99] the new physics, on the contrary, according to the methodological principles of the Schoolmen, must be called a physical knowledge properly mathematical, or a science *formally* mathe-

[97] J. Maritain, *The Degrees of Knowledge*, p. 59. See also "The Conflict of Methods . . . ," pp. 532–533; and Deely, "The Philosophical Dimensions of the Origin of Species," Part I, Sections III, IV, and V, esp. pp. 136–137 and 145–146.

[98] Randall, *Aristotle*, p. 165.

[99] On this point, see Maritain, *The Degrees of Knowledge*, "Table of the Sciences," pp. 38–46, and "Structures and Methods of the Principal Kinds of Knowledge," pp. 53–60, for indispensable clarifications.

matical and *materially* physical: a formula which . . . condenses all its properties.[100] Doubtless the conception of physico-mathematics that the French physicist Pierre Duhem (and Hirn before him) defended was too mathematical and not sufficiently physical, nevertheless Duhem was right in thinking that the phenomena can be analyzed quantitatively without the existence of qualities being denied, and that the scientific method derived from Galileo and Descartes can be used without its involving in any way philosophical incompatibility with Aristotle's metaphysics.[101]

But in point of fact knowledge of a physico-mathematical sort was limited among the Ancients and the Schoolmen to certain very particular disciplines, such as astronomy and acoustics; . . . and . . . the idea of establishing a universal mathematical interpretation of physical reality by submitting the fluent detail of phenomena to the science of number nevertheless remained foreign to most of them.

Therefore, on the day when quantitative physics, having its own specific character and possessed of its own exigencies, moved to take its place within the order of sciences and to proclaim its rights, it was to enter inevitably into conflict with the philosophy of old—not only because of the error which vitiated the latter in the experimental field, but also, and this is more remarkable, because of the radical difference which separates—with respect to what is genuine and legitimate in each one of those two manners—the old manner of approaching physical realities from the new manner of approaching them.[102]

F. The conflict of methods at the dawn of modern times: The ascension of platonism and its consequences

For the world of classical antiquity, it was the power of the philosophical mode of explanation, that is, the possibility of assigning reasons for being in terms of principles and causes, which preoccupied thinkers, to the point of inclining them to overlook the limits imposed on such explanations by the state of empirical research at any given period. This in turn led to carelessness with respect to their intrinsic dependency on the sciences of observation, and so to leaving aside the proper task of a straightforward philosophy of nature, which is to assign the reasons for what is given to it and to gain an understanding of that datum. By the time of Galileo and Descartes, custom and long habituation to one mode of explanation had converted this tendency into a veritable myopia.

For the post-classical but pre-Darwinian world, it was just the opposite inclination which carried the day. Thinkers of this period were over-

[100] See *ibid.*, "Knowledge of the Physico-Mathematical Type and Philosophy," pp. 60–64, and "Modern Physics Considered in its General Epistemological Type," pp. 138–140.

[101] In any way, that is, save sometimes in the order of imagination with its explanatory images (cf. Maritain, *The Degrees of Knowledge*, pp. 64, 179–180, 181, 182–184). For an interpretation of the new physics exclusively in terms of the changed image of the physical world wrought in the sixteenth and seventeenth centuries, and not at all in terms of the epistemological principles determining the topography of the mind, see I. Bernard Cohen, *The Birth of a New Physics* (New York: Anchor, 1960).

[102] J. Maritain, "The Conflict of Methods . . . ," pp. 529–531.

whelmed with the discovery of the possibility of a universal knowledge of nature which would, on the one hand, save the sensible appearances, while on the other hand it would, by recomposing those very appearances in the field of mathematical ideality, make possible a type of deduction leading to a measure of prediction and control of physical phenomena completely impossible within the order of ontological explanation. But such a reconstituted universe, to the extent its creators became fascinated with the power of their explanatory mode to the neglect of its limits, tended, for reasons we have already indicated, toward mechanism and toward a mechanistically deterministic view of nature as toward an ideal limit.

Thus it is not enough to note that the physico-mathematical method was finally evolved by anti-scholastic thinkers, whom the very excess of their confidence in the application of mathematics to sense-perceived nature led instinctively to mechanism. We also must emphasize that the natural and irrepressible drive of the intelligence towards being and causes, when it met the physico-mathematical method must almost necessarily cause this discipline to be mistaken for a natural philosophy. It is because of this almost inevitable illusion that the new scientific method found itself from the very beginning, by virtue of the historical conditions of its genesis, quite ready to undergo the contamination of extraneous philosophies, and to become dependent upon a metaphysics like the Cartesian mathematicism—an accident inversely resembling that which had linked Aristotle's metaphysics to the erroneous theories of the physics of old.[103]

In the same way that the explanatory inclination which dominated in classical antiquity was brought up short in the face of physics in the modern sense of the word, the explanatory inclination of the modern period and of the so-called (because formally mathematical) exact sciences has in its turn "been brought up short in face of biology and experimental science (to say nothing of the moral sciences which concern philosophy even more closely.)"[104] The evolutionists have become quite sensitive on this point. Thus Mayr, following Scriven, considers that "one of the most important contributions to philosophy made by the evolutionary theory is that it has demonstrated the independence of explanation and prediction," that "indeterminacy does not mean lack of cause, but merely unpredictability."[105] Randall's research has led him to concur in Mayr's conclusion in this regard, though for slightly different reasons: "We often think this is a recent modern discovery, because it was forgotten in the seventeenth century."[106]

[103] *Ibid.*, p. 535.
[104] Maritain, *The Degrees of Knowledge*, pp. 45–46. See Randall, "The Significance of Aristotle's Natural Philosophy," in his *Aristotle*, pp. 165–172.
[105] Ernst Mayr, "Cause and Effect in Biology," *Science*, 134 (10 November 1961), pp. 1504 and 1505, respectively. See Michael Scriven, "Explanation and Prediction," *Science* 130, (26 August 1959), pp. 477–482.
[106] Randall, *Aristotle*, p. 184.

It is in this light that one best appreciates Hayek's remarks concerning the contemporary theory of natural selection:

> It is significant that this theory has always been something of a stumbling block for the dominant conception of scientific method. It certainly does not fit the orthodox criteria of 'prediction and control' as the hallmarks of scientific method. Yet it cannot be denied that it has become the successful foundation of the whole of modern biology.[107]

What we are witnessing in our own day seems to be that very "reconstruction" which did not come about in the seventeenth century (or eighteenth, or nineteenth), and which perhaps *could not* come about before it was possible in the actual light of history to envisage not only the explanatory power but also the limits intrinsic, in typically appropriate ways, to both of these pure epistemological types.[108] For "whoever seeks to work towards the integrating of philosophy and experimental science must be at once on his guard against both a lazy separatism and a facile concordism and re-establish a vital bond between them without upsetting the distinctions and hierarchies which are essential to the universe of knowing."[109] What is called for is nothing more or less than an adequate perspective by which an integrated synthesis of all sciences can be joined with the autonomy proper to each distinct science. To this end, it seems, "two cases should be very clearly distinguished: the case of physico-mathematical science and the sciences of which it is the type, on the one hand, and the case of sciences like biology and psychology on the other,"[110] sciences of which philosophical explanation is the type.

Like the Monday morning quarterback, we are speaking here with the wisdom of retrospect. In the immediate press of historical events, essential structures are seldom so generous in showing themselves. Nonetheless, be it only retrospective, wisdom is still wisdom, and we must distinguish two very different aspects in the revolution which took place under the impetus of Galileo's turning of his telescope toward the sun and discovery of spots moving across its face, thus spelling the ruin of that image of the physical universe which depended on the perfection and immutability of the celestial spheres. As soon as the distinction between heavenly or incorruptible and earthly or corruptible matter was disposed of, the "ruling cause" of generations and corruptions in the sublunary

[107] F. A. Hayek, "The Theory of Complex Phenomena," in *The Critical Approach to Science and Philosophy*, Mario Bunge, ed. (Glencoe: Free Press, 1964), pp. 340–341. In section V of this essay, "The theory of evolution as an instance of pattern prediction," pp. 340–343, Hayek sets forth very clearly the ontological, a-heuristic or "negative" and non-imaginative explanatory structure of contemporary evolutionary theory as it grounds itself in the concept of natural selection.

[108] Maritain, in "The Conflict of Methods . . . ," p. 534, expresses a similar view.

[109] Maritain, *The Degrees of Knowledge*, p. 60.

[110] *Ibid.*

region was also removed. This is the first aspect of the revolution which began with Galileo.

The consequences of this as a speculative event, and not merely as a cultural event, can only be understood speculatively.[111] Traditional analyses of essence cannot be judged adequately unless they are first thought through in the light of such observations as this one by the outstanding evolutionist, Theodosius Dobzhansky:

> If the environment was absolutely constant, one could conceive of formation of ideal genotypes [i.e., substantial structures] each of which would be perfectly adapted to a certain niche in this environment. In such a static world, evolution might accomplish its task and come to a standstill [one thinks of the *Timaeus*]; doing away with the mutation process would be the ultimate improvement. *The world of reality, however, is not static.*[112]

If not psychologically, at least logically, and if one wished to remain within the explanatory mode which seeks to assign reasons for being and not just provide freely constructed schema sufficing to "save the appearances," there was an immediate and inescapable consequence to the disappearance of the celestial spheres as *causa regitiva*, as regulative or "ruling" cause: the habits of typological thinking, which were intrinsically determined by the assumption of such a "ruling cause," had to be severely modified, and in several respects abandoned. For if the phenomena are to be comprehended in an environment where *nothing* is free from substantial change, and if the exceptionless law of causality is to be integrally respected, there must be more to grasping the nature of a species than ignoring all individual peculiarities of the members which make it up. The humanly envisaged ideal "types" no longer bear a simple and immediate relation to what the natural processes are "up to." When the immediate and invariant relation of forms to the *causa regitiva* is suppressed, in short, specific fixity is replaced by the developmental potentialities of the particular individual within the specific population having to realize themselves in unusual as well as usual circumstances. In such a milieu, it becomes a question of understanding the real event and individual, not as an instanced ideal, but as an interaction product.

This aspect of the Galilean revolution remained purely virtual, however, until the actual establishment of evolutionary theory and the develop-

[111] "In medieval literature, the problem of celestial movers was not created by theologians. . . . The problem of celestial movers was entirely a scientific one having many ramifications." (Weishcipl, *art. cit.*, pp. 151–152). Indeed, practically all of the neo-scholastic dilemmas before the evolutionary problematic may be directly traced to their inherited tendency to treat scientific problems, whether pure or mixed, *modo philosophico*: see Part Three of M. J. Adler's study, *The Conditions of Philosophy* (New York: Atheneum, 1965), pp. 231–294, Ch. 15 in particular, pp. 250–261, esp. p. 256.

[112] Theodosius Dobzhansky, *Genetics and the Origin of Species* (3rd ed., rev.; New York: Columbia, 1951), p. 74: emphasis supplied.

ment in our own century, through the marvellous writings of such men as Mayr, Huxley, and Simpson, of taxonomic classification techniques which gradually found ways to conform to the intricate patterns of phylogenetic descent within evolutionary lines.[113] Certainly, a good deal more reflection, especially at a purely philosophical level, is necessary in this regard. Nonetheless, it is already possible in these terms to see that the ultimate import of the Galilean revolution for philosophy derives from the sciences of observation, understanding philosophy as synonymous with the natural-physical in contrast with the mathematical-physical mode of explanation, and hence as applying to every science or art capable of understanding not just the mathematical forms but the proper causes of the things it studies.[114]

The decisive difference between the classical and contemporary world-view turns out to be neither a preference for typically distinct

[113] See, for example: Ernst Mayr, *Systematics and the Origin of Species* (New York: Columbia, 1942); E. Mayr, E. G. Linsley, and R. L. Usinger, *Methods and Principles of Systematic Zoology* (New York: McGraw-Hill, 1953); Julian S. Huxley, ed., *The New Systematics* (Oxford, 1940); George Gaylord Simpson, *Principles of Animal Taxonomy* (New York: Columbia, 1961); Glenn L. Jepsen, George Gaylord Simpson, and Ernst Mayr, editors, *Genetics, Paleontology, and Evolution* (New York: Princeton, 1949).

[114] "From one point of view, there can be no difference between a philosophical analysis of nature and a study of nature in the scientific sense: all explanation, when it is not mathematical, assigns reasons for being.

"Yet from another point of view, there is a sense in which natural philosophy and natural science do subdivide the order of rational knowledge of nature. The question of the difference between philosophy and science and of the relations which their respective explanations sustain is a difficult one which, perhaps more than any other, has exercised contemporary reflections. It is not even agreed among those who treat this question that philosophy constitutes a mode of rational understanding in its own right; but I think that once it is seen that, with respect to the sensible, natural world, just as there are some questions for which laboratory or field research is indispensable (e.g., how does photosynthesis take place? what is the average life-span of a star? are there extinct life forms? or why do lemmings recurrently plunge to their death in the sea?), so also there are other questions for which such research is adventitious (e.g., what is change? what is chance? what is place? what is the basis for the prior possibility of agreement? why is change possible? how do relations exist? is the existence of an order of purely spiritual beings a real possibility?), then it is necessary to admit that (a) in relation to experience science and philosophy differ between themselves according to the manner in which their respective explanations depend thereon, and that (b) both belong to the order of rational understanding, sharing formally in an identical set and sequence [formally, not at all materially, speaking] of questions. (We should recognize, too, that not all questions can be assigned preclusively to either science or philosophy; there are also, so to speak, 'hybrid' questions, questions for which laboratory or field research are superfluous in certain respects and helpful in others—such questions as, how is man unique? what is good for man? what role does chance play in the constitution of the world? or . . . what are the natural species or kinds which ordinary experience indicates to be real?)

"This assertion depends, of course, on there being a real analytical distinction between knowledge and experience. That there is such a distinction is plain from the fact that experience functions both as a source and as a test of our knowledge in both philosophy and science, which would be impossible if the two were not somehow distinct. In fact, this difference between experience and knowledge lies at the base of rational understanding, inasmuch as it defines the respective spheres or orders of observation and explanation." (John N. Deely, "The Philosophical Dimensions of the Origin of Species," Part I, *The Thomist*, XXXIII [January, 1969], pp. 101–102, text and fn. 50.) See further references in fn. 42 above.

explanatory modes nor a mere transformation in the physical image of the universe, but rather a *datum*, an element of experience for which no logical construction can be substituted and upon which all the logical constructions of the science of nature finally rest, the realization, specifically, that nothing in the universe is exempt from radical transformation.

The second aspect of the revolution which began with Galileo and which we must now distinguish, however, was the aspect that was not merely virtual both historically and philosophically, but *formally constitutive* from a culturological standpoint. This aspect pertains to sciences of explanation rather than to those of observation. Indeed, the ontological implications of the spots on the sun were the last thing the revolutionaries wished to follow out; it sufficed for them that these sun-spots invalidated, or rather smashed, the traditional image of the physical world. "When the historic conflict between the Aristotelian physics and the new physics opened, both sides were equally convinced that this was a conflict between two philosophies of nature."[115] The physico-mathematical science founded by Galileo and Descartes was taken by its proponents as a philosophy of nature and indeed as the only authentic one. Moreover, the predictions it made possible were put forward as *proofs* of the validity of its explanations.[116]

> Then it happened that the Cartesian mechanism achieved the obliteration of the old distinction between the philosopher of nature (*physicus*) and the mathematical interpreter of nature (*astronomus, musicus . . .*). When we re-read the great work of Newton significantly titled *Philosophiae Naturalis Principia Mathematica*, we realize that the Newtonian science, once considered by positivists as the archetype of positive knowledge, was far from having rid itself of ontological ambitions.[117]

The post-Galilean thinkers did not explore the possibility of understanding the phenomena of nature in their full physical reality as interaction products, for which it is necessary to retain the notion of natural units or substance.[118] Instead, they set about the comprehension of concrete particular cases in the quite different way of applying to the details of phenomena themselves, just as they are coordinated in time and space, the purely formal connections of mathematically expressible relations. In this way they came to seek as the ideal type of modern science a knowledge "to be at once experimental (in its matter) and deductive

[115] Yves Simon, "Maritain's Philosophy of the Sciences," p. 97.

[116] Already a sign of profound confusion over the nature of reason's distinct modes: see text above at fn. 94.

[117] Simon, *art. cit.*, p. 97. See the text of Newton's letter to Fr. Pardies, cited in text below at fn. 179.

[118] See esp. Ashley, "Does Natural Science Attain Nature or Only the Phenomena?"; and his "Change and Process," second reading in Part II, Section IV of this volume, The Metaphysical Issues.

(in its form, but above all as regards the laws of the variations of the quantities involved)," capable for that very reason of devising endlessly varied "means of utilizing sensible nature (from the point of view of quantity indeed, but not from the point of view of being)."[119] Within such an ideal type, to be sure, "lawfulness is no longer limited to cases which occur regularly or frequently but is characteristic of every physical event. . . . Even a particular case is then assumed, without more ado, to be lawful."[120] "The step from the particular case to law . . . is automatically and immediately given by the principle of the exceptionless lawfulness of physical events."[121] What happens to chance factors in this new world-picture? (And it is indeed a picture, a *physical image* comparable in every way to the astrological attitude toward the celestial spheres as all-determining). "The distinction between lawful and chance events" is eliminated.[122] The *actual course* of history, the "configurational" in Simpson's sense, ceases to have any causal import or consequently any explanatory potential; it becomes the accident which must be discarded if we are to understand the real determinants of any given process.[123] Propositions formed in the Aristotelian explanatory mode, it is acknowledged, "show an immediate reference to the historically given reality and to the actual course of events."[124] By contrast, it is likewise acknowledged, concepts formed in the Galilean explanatory mode "unquestionably have in comparison with Aristotelian empiricism a much less empirical, a much more constructive character than the Aristotelian concepts, based immediately upon historical actuality."[125] But we are assured (by one who has certainly never grasped the type of explanation essayed by Aristotle and its implications for a world with no eternal heavens) that any immediate reference to the historically given reality and the actual course of events "really means giving up the attempt to understand the particular, always situation-determined [=process- as

[119] Maritain, *The Degrees of Knowledge*, p. 45. See also Maritain, *Science and Wisdom* (New York: Scribner's, 1940), pp. 43–44; and Gavin Ardley, *Aquinas and Kant* (New York: Longmans, 1950).

[120] Kurt Lewin, "The Conflict Between Aristotelian and Galileian Modes of Thought in Contemporary Psychology," Ch. 1 of *A Dynamic Theory of Personality: Selected Papers of Kurt Lewin* (New York: McGraw-Hill, 1935), pp. 25–26. (The references in fn. 105 above are relevant here.)

[121] *Ibid.*, p. 31.

[122] *Ibid.*, pp. 6 and 25–26.

[123] *Ibid.* This is so because there is no longer any criterion for distinguishing between what occurs by nature and what occurs by chance or violence, between *event* and *encounter* (see fn. 155 below), between exceptionless *causality* and exceptionless *lawfulness*—this last particularly, because in the "Galileian mode" the determinism of nature is conceived in a formally mathematical rather than ontological sense, and moreover entirely displaces the latter: see fns. 67 and 73 above.

[124] Lewin, p. 12.

[125] *Ibid.*, pp. 12–13.

distinct from product-determined] event."[126] "Galilean concepts, on the contrary, even in the course of a particular process, separate the quasi-historical," i.e., the incidental or configurational factor, the historically actual course of events, "from the factors determining the dynamics."[127]

"Thus and in similar ways," muses Simpson, "the descent from the ideal to the real in physical science has been coped with, not so much by facing it as by finding devices for ignoring it."[128] For in very truth, if there is no distinction between the causal and the lawful, if the concept of exceptionless causality is not (as Lewin assures us it is not[129]) in any way distinct from the conception of exceptionless lawfulness, if, in short, the only difference between the epistemological type of explanation incarnated by Aristotle and that incarnated by Galileo (after the Pythagoreans and in the tradition of Plato) is that the former is illusory while the latter is explanatory, then there is no way in which biology à la Darwin can be regarded as explanatory or scientific, *for within the epistemological type of Galilean concepts, data of paleontology and of pre-history generally are not expressive "of the vectors determinative"*[130] *of the dynamics of the evolutionary process.*

Again it is necessary to revert to the conclusion of Maritain, as being the only judgment capable of supporting the weight of the evidence:[131]

> There are two possible ways of interpreting the conceptions of the new physics philosophically. The one transports them literally, just as they are, on to the philosophical plane, and thereby throws the mind into a zone of metaphysical confusion; the other discerns their spirit and their noetic value, in an effort to determine their proper import.[132]

[126] *Ibid.*, p. 31.
[127] *Ibid.*, p. 34.
[128] George Gaylord Simpson, "The Historical Factor in Science," ch. 7 of *This View of Life*, p. 129.
[129] Lewin, pp. 6, 23, 25–26, 26 fn. 1, 31, 35.
[130] *Ibid.*, pp. 33–34.
[131] A similar consideration may have been behind Mortimer Adler's judgment that Maritain seemed, in the early twentieth century, "the only contemporary philosopher who has deeply sensed the movement of history and the point at which we stand." (*What Man Has Made of Man* [New York: Ungar, 1937], p. 242). See further Mortimer Adler, "The Next Twenty-five Years in Philosophy," *The New Scholasticism*, XXV (January, 1951), pp. 92–95; and Yves Simon, "Maritain's Philosophy of the Sciences," pp. 93–96.
[132] Maritain, *The Degrees of Knowledge*, p. 171. It is probably not far wrong to regard this "zone of metaphysical confusion" as the principal *locus* of contemporary philosophy insofar as it has drawn its exclusive inspiration from the spectacular revolutions effected in physics by relativity and quantum theory: e.g., see Lincoln Barnett's assessment of *The Universe and Dr. Einstein* (New York: Signet, 1957). (Simon delineates the epistemological architecture of this zone in *art. cit.*, 99–100, with brief lines of masterful clarity.) See fn. 43 above.

It should be noted that the peculiar intensity of this conflict in our day between the rudimentary ontology of common sense (what Bergson once called "the natural metaphysics of the human mind") and the theoretical speculations of mathematical-physics has given rise

It is to this last interpretation that one is forced by the rise of evolutionary biology.

G. Tables reversed and conflict of method renewed: The immediate obstacles to evolutionary thought

Thus, in meditating the passage of thought from classical antiquity to Darwin's world, we find ourselves returned, not indeed to Aristotle, but rather to the epistemological type of explanation immanent in his philosophy. This return has been made possible however principally by the disappearance of the celestial spheres which formed the physical image of the classical world, while it has been made necessary if we are at last to resolve "the terrible misunderstanding which, for three centuries, has embroiled modern science and the *philosophia perennis*," and which "has given rise to great metaphysical errors to the extent it has been thought to provide a true philosophy of nature."[133] Because this return has been made against the backdrop of a realized universal knowledge of nature mathematical in mode, we ought to recognize in it not the sign of a restriction and impoverishment, but of an improvement and growth within the organic structure and differentiation of thought. "Of itself, it [i.e., physico-mathematics] was an admirable discovery from an epistemological point of view, yet one to which," once freed of its ontological pretensions, "we can quite easily assign a place in the system of sciences."[134]

in philosophical circles not only to those who, like the Logical Positivists, take as primary reference and point of departure the conclusions of theoretical (mathematical) physics, and maintain the primacy of this theoretical network even in its subjection to constant and radical reformulation; but also, on the other side, to those who, like the Phenomenologists, take their point of departure from the "life-world" (*Lebenswelt*) of common experience, from the fact that man is human before he is scientific, from the fact that it is common or lived experience which is at once prior to and constitutive of the very possibility for the specialized research and experiences of the scientific enterprise, and who accordingly seek to ground the primacy of common sense over scientific (mathematical) theory. Two phenomenologists in particular stand out in this connection: Edmund Husserl (1859–1938), the founder of the movement; and Maurice Merleau-Ponty (1908–1961), his greatest French disciple. *Inter alia*, see Husserl's "The *Lebenswelt* as forgotten foundation of meaning for natural science," in *Husserliana* (The Hague: Martinus Nijhoff, 1963), VI, 48 (this article appeared in *Philosophia*, 1936); *Phenomenology and the Crisis of Philosophy*, trans. by Quentin Lauer (New York: Harper Torchbooks, 1965). And Maurice Merleau-Ponty, *The Primacy of Perception* (Chicago: Northwestern, 1964); *Phenomenology of Perception* (New York: Humanities Press, 1962); *The Structure of Behavior* (Boston: Beacon Press, 1963).

[133] Maritain, *The Degrees of Knowledge*, p. 41. See Simon, *art. cit.*, pp. 96–101.

[134] *Ibid.* Well, perhaps not all that easily, after all—at least not from the side of subjectivity, of human knowledge taken in its psychological dimension. "Quite easily" after Maritain: but so was the idea of geometry "quite easy" after Euclid, or of evolution after Darwin! See Simon, "Maritain's Philosophy of the Sciences," pp. 93, 95, 96–98.

In any case, it seems that a true philosophy of the progress of the physical and mathematical sciences in the course of modern times, precisely because it is its duty to set forth by critical reflection the spiritual values with which that progress is pregnant . . . must therefore on the one hand reveal the essential compatibility of this mathematical and empiriometrical progress with the knowledge of the ontological type which is proper to philosophy. On the other hand, it must respect the nature of the Experimental Sciences, which of themselves escape from complete mathematization, and it must render justice to their working methods, which will extend to ever larger sections of the scientific domain the more they assert their autonomy. In effect, it would be completely arbitrary to refuse to biology, and other sciences of the same epistemological type, the rank of authentic knowledge. This type of knowledge merits the attention of the philosopher and it is playing an ever more important, perhaps one day preponderant, role in the progress of speculative thought.[135]

It is necessary to keep all these historical and philosophical considerations well in mind as we move toward an assessment of the causal understanding achieved by contemporary evolutionary science. "Our first step in the effort to understand how life became natural, therefore, is to avoid," writes Loren Eiseley, "the commonly held impression that Darwin, by a solitary innovation—natural selection—transformed the Western world view."[136]

Variation, selection, the struggle for existence, were all known before Darwin. *They were seen, however, within the context of a different world view* [and, we must add, within the range or perspective principally of reason's second explanatory mode]. Their true significance remained obscured or muted. . . . It was not really new facts that were needed so much as a new way of looking at the world from an old set of data.[137]

Eiseley lists four propositions which, looking back, had to be clarified before the theory of organic evolution would prove acceptable to science. First of all, it was necessary to grasp the *antiquity of the earth.* Secondly, it was necessary to establish that there had been a true geological *succession of life-forms* on the earth. Thirdly, the extent of individual *variation* in the living world *and its prospective significance* in the creation of novelty had to be grasped. And finally, *a conception of a relative, dynamic equilibrium* had to replace the conception of the absolute, permanently balanced world-machine. In the final analysis, it was the clarification of these four propositions that made possible Darwin's world—and ours. Let us examine, very briefly, each of them in turn. It is of particular interest to note that the chief difficulties obscuring these propositions stem in every case not from classical antiquity, but from the mentality of the seventeenth

[135] *Ibid.*, pp. 200–201. (See fn. 114 above.)
[136] Eiseley, *The Firmament of Time* (New York: Atheneum, 1962), p. 68.
[137] *Ibid.*, p. 72: emphasis added.

and eighteenth centuries, that is, from early modern times, and in general from the scientific even more than from the religious temper of that modern Age of Enlightenment.[138]

The first proposition, the antiquity of the earth, was taken for granted in classical times. Aristotle was reasonably confident the earth had existed from eternity. The Christian Middle Ages saw the eternity of the world as a philosophical possibility, although it seemed to them a datum of Revelation that in fact it had had a temporal beginning, with nothing much more definite said on the matter. It was left for the biblical chronologists of the sixteenth and seventeenth centuries, culminating in the work of the Irish Archbishop James Ussher (1581–1656), to exorcise the last "illusions" of antiquity with the discovery that the world had been created precisely in 4004 B.C.

For the establishment of the second proposition concerning the succession of forms, there were required the prior attempts to classify animals and plants collected from every part of the globe, for only when classification was attempted on this scale did difficulties multiply to such a point that the successors of Linnaeus (the eighteenth century Swedish botanist who principally authored the form of classification of organisms still in use today[139]) were forced to abandon the idea that species are fixed. As late as 1815, Cuvier (the great French zoologist of the early 19th century, who, though he as much as any one man made paleontology a distinct biological science, was himself a firm disbeliever in evolution) could still contend that no discovery of intermediate forms had ever been made. "An orderly and classified arrangement of life was an absolute necessity before the investigation of evolution, or even its recognition, could take place";[140] yet not before the great voyages of discovery of the late eighteenth and nineteenth centuries did such a reconstruction of "that which was" become possible. Inasmuch as the first step in any science is to know that a possible subject of investigation exists, "to know one thing from another," as Linnaeus said,[141] the possibility of evolutionary science as such began with these voyages.

The third proposition, concerning the extent of variation and its prospective significance as a source of specific transformations, had been

[138] Cf. Loren Eiseley, *Darwin's Century* (New York: Anchor, 1961), pp. 23–24; and Michael Ruse, "The Revolution in Biology," *Theoria*, XXXVI (1970), pp. 1–22.

[139] It is necessary to add that his authorship extends "only to the *form*, the terms and names used. There have been two revolutionary changes in the *principles* of classification since Linnaeus."—Simpson *et al.*, *Life* (New York: Harcourt, 1957), p. 462. (See esp. the references given in fn. 113 above.)

[140] Eiseley, *Darwin's Century*, p. 15.

[141] *A Selection of the Correspondence of Linnaeus and Other Naturalists from the Original Manuscripts*, Sir James Edward Smith, ed. (London: Longman, Hurst, Rees, Orme, and Brown, 1821), Vol. 2, p. 460. See Secs. III and IV of "The Philosophical Dimensions of the Origin of Species" in *The Thomist*, XXXIII (January, 1969), pp. 93–130.

obscured in the classical and medieval world. It was not the conception of scientific method found in Aristotle's *Posterior Analytics* which was the source of this obfuscation; rather was Aristotle's presentation obfuscated by the idea of eternal species.[142] And this idea, as we have seen in some detail, in turn derived from the presence in the classical representation of the universe of the unchanging heavens which kept all transformations in fixed categories. In principle, the significance of variation was brought into the open by the disappearance of the celestial spheres c. 1610. In fact, the invention, by Ray and Linnaeus and other classifiers of the period 1750–1850, of species immutable in themselves, i.e., fixed without any ecological reason, kept the whole issue as much in the dark as ever.

Much of the sound and fury surrounding evolutionary theory is due to a misapprehension of sorts. Evolution initially had no pretensions to the status of a *Weltanschauung*, nor did it seek to serve as a substitute for the Christian doctrine of creation. . . . The theory of evolution actually grew out of a conflict between *two distinct and opposing biological theories*. It was a family quarrel. The dominant biological theory was that *of a fixed and immediate creation of species*. This of course has little or no reference to the theological doctrine of creation *ex nihilo*. Nor is the concept of the fixity of species a logical deduction from the philosophical doctrine of the immutability of essence, although the genus and species of Linnaeus do carry some of the logical and conventional characteristics of the Aristotelian genus and species.[143]

Here again, it was the sciences of observation which rescued theorists from the illusions consequent on confusing the second explanatory mode of reason with the first.

Theories of cosmic evolution, of suns and planets emerging from gaseous nebulae in space, appeared almost simultaneously with the first intimations of organic change. The timeless Empyrean heaven was now seen to be, like the corrupt world itself, a place of endless change, of waxing and waning worlds. Although the fact waited upon geological demonstration, the new astronomy with its vast extent of space implied another order of time than man had heretofore known. For a little while the public would not grasp what the sky watchers had precipitated. It would have to be brought home to them by the resurrection of the past.[144]

Finally, let us note that Eiseley's fourth proposition likewise, the conception of the world as being in a relative rather than an absolute, and

[142] Complementary to the discussion in fn. 53 above, it is worth referring the reader at this point to the remarkable conclusions concerning the history and philosophy of science which emerge at the end of Benedict Ashley's important study of Aristotle's *Treatise on the Heavens:* see "Aristotle's Sluggish Earth, Part II," *The New Scholasticism*, XXXII (April, 1958), pp. 230–234.

[143] William E. Carlo, *Philosophy, Science and Knowledge* (Milwaukee: Bruce, 1967), p. 118. (While agreeing with Dr. Carlo's historical point here, I must disagree almost equally completely with his general assessment of the evolutionary question.)

[144] Eiseley, *Darwin's Century*, pp. 35–36.

a dynamic rather than a static, equilibrium, and the idea of the possibility of unlimited organic change which is bound up with this proposition, follows in principle upon the removal of the unchanging spheres, the *causa regitiva*. For "all that the Chain of Being actually needed to become a full-fledged evolutionary theory was the introduction into it of a conception of time in vast quantities added to mutability of form. It demanded, in other words, a universe not made but being made continuously."[145] Yet not until the end of the eighteenth century were such ideas entertained on a wide scale, and even then thanks principally to the popularity of one man, Comte de Buffon (an eighteenth century French naturalist who authored a voluminous natural history "so complete and so well written that it is still a household work in France"[146]).

Just as the clarification of the proposition concerning the significance of variation laid to rest the ghost of typological thinking (more exactly, of the reification of ideal types), so the clarification of this proposition disposed of the ghost of preformism, the view that holds, with regard to the development of individual organisms, that all the physical and psychological traits and characteristics of the mature adult are present actually though in miniature in the sex cells, ready made, so to speak, except for size; and holds, with regard to the evolutionary unfolding as a whole, that evolution is the working out of a built-in plan: it does not produce genuine change, i.e., novelty, but consists in the simple maturation of predetermined patterns.[147] Mayr refers to preformism as constituting, along with typological thinking, the "two basic philosophical concepts that were formerly widespread if not universally held," the rejection of which were indispensable preconditions for the formation of contemporary evolutionary theory.[148]

But here again, although preformist thinking goes all the way back to Hippocrates (460?–377? B.C.),[149] the particular expression of it which proved an obstacle for evolutionary science dated back no farther than Leibniz (1646–1716) and other enlightenment philosophers and scientists who conveyed the impetus of Newtonian mechanism in science and often deism in philosophy.

[145] *Ibid.*, p. 9. It is customary whenever "the great chain of being" is mentioned to refer enthusiastically to Professor Arthur O. Lovejoy's book of that very title. However, from the standpoint of the philosopher (as has been recently pointed out by M. J. Adler in *The Difference of Man and the Difference It Makes*, p. 57), one's enthusiasm for this particular "study of the history of an idea" must be seriously dampened by the realization that, in spite of the prodigious scholarship of its author, the book is blind to essential distinctions and finally inconsistent with itself.

[146] Simpson *et al.*, *Life*, pp. 804–805.

[147] See Theodosius Dobzhansky, *Mankind Evolving* (New Haven: Yale, 1962), pp. 24–26.

[148] Ernst Mayr, *Animal Species and Evolution* (Cambridge, Mass.: Harvard, 1963), pp. 4–5.

[149] The brief discussion of "Preformism vs. Epigenesis" in Nogar's *The Wisdom of Evolution*, pp. 292–294, contains some bibliographical material.

It was, in short, neither from classical antiquity nor from the scholasticism that extended it into medieval times that the immediate obstacles to evolutionary thought came—with the exception of a tendency to typological thinking, which by right should have been abandoned with the celestial spheres which were its mainstay. They came rather from the parts of the culture which carried the second or postulationally explanatory mode of reason over in a verbal form to the exegesis of scripture, or from those peculiarly modern thinkers who attempted to substitute the second explanatory mode of reason in its exact or mathematical form for the properly philosophical or natural physical mode of explanation which assigns reasons for being. "If the preceding analyses are correct, we can see that the central error of modern philosophy in the domain of the knowledge of nature has been to give the value of an ontological explanation to the type of mechanist attraction immanent in physico-mathematical knowledge, and to take the latter for a philosophy of nature."[150]

What seems to me to be essential in this matter, is to emphasize this fact, that there is a natural and inescapable proportion between means and ends, methods and objects, and that, every time we deal with genuine kinds of knowledge, the difference between methods presupposes as its very root, a more fundamental and more enlightening difference between objects.[151]

But if physico-mathematics were a natural philosophy, if it made manifest the essences and causes at work in the corporeal world, then it would be a knowledge having the ontological essence of physical reality as its proper and specifying object; and from then on we would see subverted and destroyed the genuine structure of this science. It would no longer be a science *formally* mathematical and *materially* physical, it would become a kind of monstrosity, a science which would be at the same time *formally* physical and ontological as to its specifying objects and *formally* mathematical as to its medium of demonstration and explanation. The natural and necessary proportion between the end and the means, between the specifying object and the explanatory tools in knowledge would be broken.[152]

Moreover, if physico-mathematics were a natural philosophy, and as such the paradigm or "type" of rational understanding of nature—of rational explanation of the world, then, with Kurt Lewin (among others), it would be necessary to arbitrarily refuse to accord to biology and other disciplines of the same epistemological type (such sciences as of their nature escape integral mathematization and insofar fail to fit the "orthodox" criteria of scientific knowledge as predictive and controlling) the status of authentic and objective knowledge.

[150] Maritain, *The Degrees of Knowledge*, p. 184. See "The Conflict of Methods . . . ," pp. 534–535, and *Science and Wisdom*, pp. 45–46.
[151] Maritain, "The Conflict of Methods . . . ," p. 538.
[152] *Ibid.*, p. 535.

If, however, by contrast, Mayr and Scriven are right in contending that the organization of evolutionary research has demonstrated the independence of explanation and prediction, then, in the light of the essential considerations bound up with such a demonstration, it becomes necessary to acknowledge that the significance of Darwin consists less in any particular discovery than in a return to the ancient conception of science as reasoned facts. As Eiseley puts it: "It was not natural selection that was born in 1859, as the world believes. Instead it was *natural selection without balance*,"[153] i.e., *a returning to Aristotle's epigenetic view of individual development*—"he reasoned that the best way to explain both the repetition of type and the production of novelty was to recognize the potential factor in the reproductive material and the developmental process as the progressive education or actualization of adult form"[154]—*minus the unchanging environmental reference* of the celestial, immutable spheres, which were originally a second-mode explanation (in mathematical form) anyway, and which moreover (as *causa regitiva*) were the sole guarantee that the relation of generator-generated would be absolute and not just relative across the ages. "Aristotle's concept of nature, with the operation of chance, indeterminism, and the equivocal causality of other natural cosmic agents, easily places the space-time dimensions of natural species within the theoretical structure of his natural system."[155]

[153] Eiseley, *The Firmament of Time*, p. 81.

[154] Nogar, *The Wisdom of Evolution*, p. 292. See "The Philosophical Dimensions of the Origin of Species," Part I, p. 131 text and fn. 115.

[155] Nogar, "Evolution: Scientific and Philosophical Dimensions," p. 60. Moreover, it is necessary to point out what is in itself of great philosophical interest, namely, that the idea of natural selection, insofar as it presupposes the mutual interference of independent lines of causation (and this is what is essential to the notion), bears witness on the one side to an *irreducible pluralism* in nature, the plurality of causal series which meet at a given moment; and on the other side, it coincides with the classical idea of *chance* as that notion was formulated and developed in the Aristotelian tradition.

Once this has been realized, one immediately sees that almost all of the recent controversies over "teleology" and an over-all direction or goal for the evolutionary universe have been the consequence of failure to draw the proper distinctions. So far as the theological side of these debates go, Nogar brought this out clearly in his exchange with Francoeur over the question of whether from within the universe of progressive development, with its order and disorder both cosmic and human, man can discover ultimate meaning—a finality and direction for the universe *as a whole*: see "The God of Disorder" in *Continuum*, 4 (Spring, 1966), pp. 102–113, by R. J. Nogar; "The God of Disorder II: A Response," by R. Francoeur, in *Continuum*, 4 (Summer, 1966), pp. 264–271; and "The God of Disorder III: A Postscript," by R. J. Nogar, *Continuum*, 4 (Summer, 1966), pp. 272–275. On the philosophical side, there is the underlying problem of progress in evolution, which is itself centered on the question as to the role chance plays in the constitution of the world: see J. N. Deely, "The Philosophical Dimensions of the Origin of Species," Part II, *The Thomist*, XXXIII (April, 1969), Sections VII and VIII, pp. 290–335.

On the classical notion of chance, the following texts are adequate: Aristotle, *Physics*, Bk. II, and the *Metaphysics*, Bks. 11 and 12. (Marvellously simple explanations of Aristotle's texts on the notion of physical chance can be found in Yves Simon, Ch. X of *The Great Dialogue of Nature and Space*, pp. 181–205; and in J. H. Randall's book, *Aristotle* [New York: Columbia, 1960], pp. 172–188, 229, *inter alia*. See also Yves Simon, *The Tradition of Natural Law* [New

H. The state of the methodological question

And yet it is not strictly correct to speak here of a *return* to the ancient conception of natural, i.e., philosophical, as opposed to mathematical, science; for although Darwin's great theory does indeed force a restoration of the distinction between the philosopher of nature and the mathematical interpreter of nature, still, coming as it does after three centuries of mathematical interpretation of nature have changed the face of the world, this restoration is now achieved at a higher or more mature level of cultural development within the organic structure and differentiation of the mutually irreducible (and so irreplaceable) ways of knowing. Moreover, this restoration makes it possible for the first time for natural philosophy to achieve, beyond an assessment of the ontological disposition of this universe, an authentic understanding of the balance between the necessary, the contingent, and the fortuitous in the course of events—something completely impossible as long as the Aristotelian tradition remained "basically typological resting essentially upon fixed finalities," and so "opposed to a true evolution of nature in its very theory of scientific knowledge and understanding."[156]

A closer look at nature, provided by the very realistic empirical sciences which Aristotle founded, reveals that time and space are essential properties not only of individual substances but of species themselves. Understanding which abstracts from the essential condition of the space-time contingency of natural bodies is illusory. Man cannot know the nature of a star, a camel, a salamander or a man unless he knows its origins and development, its proper space and time which makes it to be what it is.[157]

When all is said and done, therefore, and just because it stands alone, or almost alone,[158] among the great modern scientific theories as truly natural in its explanatory structure, Darwin's theory portends a denoue-

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York: Fordham, 1965], pp. 41–66, esp. pp. 54–58.) Thomas Aquinas, *Summa*, I, q. 115, art. 6, & q. 116, art. 1; *In II Physicorum*, lects. 7–10; *In II Met.*; and *In XII Met.*, lect. 3. J. Maritain, on "Chance," in *A Preface to Metaphysics* (New York: Mentor, 1962), pp. 113–141.

[156] Raymond J. Nogar, "The God of Disorder," *Continuum*, 4 (Spring, 1966), p. 108. (Originally presented as a paper at the 1965 ACPA under the title, "The Mystery of Cosmic Epigenesis.")

[157] *Ibid.*, p. 109.

[158] Beside it stand the depth-psychology which springs from Freud and the sociology and culturology which alike spring from Durkheim. What is at work within these currents—becoming very broad now—is nothing less than the revolution in scientific understanding which we have been discussing in terms of epistemological types. See R. M. MacIver, *Social Causation* (New York: Harper, 1964); and Gerard Radnitzky, *Contemporary Schools of Metascience* (2nd. ed., rev.; Copenhagen: Munksgaard, 1970).

ment to the "epistemological drama" of modern times, a resolution of the "tragic misunderstanding" which took place at the time of Galileo and Descartes and has for three centuries embroiled science and philosophy. If this be so, the rise of evolutionary science is not only a great advance in our *understanding of nature*, the greatest such in modern times; it is a spiritual advance as well, I mean an advance in our *understanding* of what *knowledge itself* is, "its values, its degrees, and how it can foster the inner unity of the human being."[159] That is why it seems to me that the passage from classical antiquity to Darwin's world (which suffered all the other cultural vicissitudes, of course, social, political, religious, sociological, psychological, besides the purely philosophical ones I have attempted to trace [not unaware of the gaps in the outline], but which lie beyond the compass of the logic of the epistemological types of rational knowledge) must be seen not merely as circular—a complementary rivalry between two alternative views concerning the aim and method of the study of nature—but rather as *spiral*, as an expression of that essential tendency of human intelligence to correct over the long run its own excesses, and in doing so to move toward that establishment of "the freedom and autonomy as well as the vital harmony and mutual strengthening of the great disciplines of knowledge through which the intellect of man strives indefatigably toward truth."[160] This is the only alternative to that disastrous imperialism in which now one and now another type of knowing claims at once to face the full range of reality (or at least as much of it as deserves scrutiny) and at the same stroke to absorb all "genuine" knowing into itself. It would also seem to hold the sole hope for the future of humane civilization.

But we have, for good or ill, more or less aware of its implications and willingly or no, all of us made the passage to Darwin's world. From a world in which the heavens, at least, hinted exemption from transformations, to a world in which nothing at all is exempt from process: that is the essential datum. That is what locates us in Darwin's world and no longer in the classical or medieval world.

It is by reference to that single point of observation—but how many years, how many lives, and how much anguish is compressed in this one point of our collective intellectual biography!—that we are able to refer (in the accents of the curator of culture and historian of ideas) to "the idealistic philosophy of Plato and the modifications of it by Aristotle";[161] while from the standpoint of the difference between sciences of observations and sciences of explanation, that same datum compels us—paradoxically, indeed—at one and the same time *to "claim* that the typological

[159] Jacques Maritain, "On Human Knowledge," in *The Range of Reason* (New York: Scribner's, 952), p. 3.
[160] *Ibid.*, p. 11.
[161] Ernst Mayr, *Animal Species and Evolution*, p. 5.

philosophies of Plato and Aristotle are incompatible with evolutionary thinking"[162] *and* (just because "the mind, even more so than the physical world and bodily organisms, possesses its own dimensions, its structure and internal hierarchy of causalities and values—immaterial though they be"[163]) *to acknowledge* that, "surprisingly enough, the fundamental issues involved in the doctrinal differences between Plato's system and Aristotle's view are raised again today by the advances of evolutionary theory."[164] So that Darwinism, more than any other doctrine responsible for the now dominant evolutionary vision of all reality, turns out to have been a thoroughly dialectical event.

III. WORLD-VIEW AS LOGOS AND AS MYTHOS

We have already noted how mathematical-physical knowledge, obliged as it is to substitute quantitatively reconstructed entities for the sensible and qualitatively determined objects of experience, when translated into words and presented as an explanation of the world of experience, results in the creation of myths which superimpose on the universe of experience an entirely different one, a universe of provisory representations, sometimes, indeed (as in the case of Einstein's space, or the case of wave-mechanics), only reductively or analogically figurable, but always myths or fables, since their whole value derives, not from the essence of the real envisaged in itself, but from the mathematical relations they sustain; so that, if accorded an ontologically explicative value, the result of such translation is a casting of the mind into a zone of metaphysical confusion. And we have noted too that it is in this sense of transporting the conceptions of mathematical-physics literally on to the philosophical plane, that many elements of the contemporary scientific world-view belong to the order of myth rather than of understanding.[165] There is quite another

[162] *Ibid.*: my emphasis.

[163] *The Degrees of Knowledge*, p. ix. For discussion of this last point, see John N. Deely, "The Immateriality of the Intentional as such," *The New Scholasticism*, XLII (Spring, 1968), pp. 293–306.

[164] R. J. Nogar, *The Wisdom of Evolution*, p. 316.

[165] And since moreover "there is no other way for the Philosophy of Nature to take up into its own order the well-founded myths of physico-mathematical knowledge than to become a fabricator of myths in its turn," then "perhaps it is fitting that the Philosophy of Nature add to its philosophical knowledge, properly so called, a region of philosophical myths destined to harmonize it with the well-established myths involved in physico-mathematical theories. In this way it may complete its union with the experimental body that the sciences construct for it. And so, though there can be no continuity as to the rational explanation and the understanding of things between physico-mathematical theories and the Philosophy of Nature, a secondary continuity may be established through their common ground of imagery" (J. Maritain, *The Degrees of Knowledge*, pp. 183–184), a secondary continuity thus between "two heterogeneous rational conceptions between which mathematical formalism alone assures [primary] continuity" (p. 186). See fn. 65 above.

sense of myth as well, which we will discuss in a moment; but having discerned the spirit and proper noetic value of the role played by mathematical knowledge in our understanding of the phenomena of nature, it would be well if we delineated first the structure of rational knowledge as it pertains to the *proper explanation and understanding*—rather than simple interpretation indifferently commingling mental fictions and observable processes—of the evolutionary universe.

A. World-view as *logos*

We have seen that the scientific understanding advances by a circular process or a kind of dialectic in which the mind begins with experience or observation, works out explanations in terms of its observations, gathers new evidence, modifies previous explanations to take account of the new data, and so on endlessly, with techniques of observation more and more sophisticated giving rise to explanatory structures more and more refined.

We have seen also that in this continual going and coming between observation and explanation, the mind works in two distinct explanatory modes, one philosophical, in which the rule of explanation is to assign the reasons for being or proper causes of phenomena (that which is observed); the other mathematical, in which the rule of explanation is to construct whatever causes or hypotheses would by their assumption make possible the calculation from the principles of mathematics (especially geometry) of the conditions for the phenomena in question for the past and the future—a skillful effort "to save the phenomena," making as such no pretense to arrive at the nature of things or to explain them in terms of their true, or rather, *proper*, causes and principles of being; so that, if its procedures are transparent to itself, the scientific mind will always subordinate the second mode to the first, in which alone a true understanding, both physical and literal, of the world of nature is achieved.[166] For "not all aspects of nature can be known by a quantitative procedure, and even those which are known in this way have to be interpreted in the light of the nature of a thing which underlies its quantity."[167]

[166] "Undoubtedly it is this genuine distinction between the intellectual habit of natural science and the intellectual habit of mathematico-natural science that has led so many of our philosophers to believe that our knowledge of nature must be split into two levels," comments Ashley. "Nevertheless, this mathematico-natural science, important as it is, does not constitute a new level of natural science but is best conceived as an instrument used by the natural scientist, a technique like his other techniques." ("Does Natural Science Attain Nature or Only The Phenomena?" p. 81). Simon (*art. cit.*, pp. 100–101) gives an express idea "of the distinctions which should be made and of the phases which should be surveyed in order to appreciate the bearing of physical [i.e., mathematico-physical] theories with regard to the knowledge of the real."

[167] B. Ashley, *The Arts of Learning and Communication* (Chicago, 1961), p. 379.

Thus world-view as *logos* refers to our understanding of nature so far as it is achieved in the light of facts or evidence, which light must be taken in three senses. Any fact is a witness to the activity of the mind, since in order to be "given" or *datum* something must be simultaneously "received" or "actively accepted" and conceived—*factum*. Nevertheless, so far as it pertains to the *order of observation*, the notion of fact or *datum* has a fundamental sense, absolutely binding on every exercise of the speculative understanding: it is, in Simon's words, "the object of an intuition"—an element of experience, let us say—"for which no logical construct can be substituted and upon which all the logical constructions of the science of nature finally rest."[168] So far as it pertains to the *order of explanation*, on the other hand, the notion of fact divides before the mind, so to speak, under the pressure of a critical analysis of the rational processes used in each particular case:

> The more the mathematical is reduced to the role of enabling one by measurement and calculation to get a surer grasp of the undiluted physical and of those causes and conditions whose character as *entia realia* [or beings independent of the considering mind] the philosopher has no reason to question, the more does the result deserve to be called a fact. But the more the physical is reduced to the role of intervening only as a mere instrument for discriminating between theoretical constructions whose proper value is constituted by their mathematical amplitude and coherence or as as a mere basis for entities which the philosopher has good reason to regard as beings of reason, the more should the result be transferred to the order, not of fact, but of explanatory image.[169]

[168] Simon, *art. cit.*, p. 91. Nor is this fundamental sense rendered any the less binding by the easy observation that the original description or experience is already steeped in theory (Karl Popper, *The Logic of Scientific Discovery*, pp. 59ff.) and so itself dependent on a background of presuppositions and assumptions (D. M. Emmet, "The Choice of a World-Outlook," *Philosophy*, 23 [1948], p. 211). For the distinction I have insisted upon between observation and explanation, together with this definition of *datum* on which it rests, derives its validity from its reducibility to an instance of the principle of contradiction: "Experience is a source of knowledge about the things experienced, and it provides a test for what claims to be knowledge of the things experienced. To function in these ways as a source and as a test, it must be distinct both from the things experienced and from the knowledge of those things" (Adler, *The Conditions of Philosophy*, p. 132). As Waddington might put it (cf. *The Ethical Animal*, p. 27), temporal and genetical overlap should not prevent us from recognizing that the processes of observation and those of explanation are in important ways different in kind. Otherwise, it would make no sense to maintain that "to seek objectivity in questions of fact is a primary obligation" (Emmet, p. 215), or to speak of "a discipline of accuracy in dealing with empirical evidence" (*ibid.*). It is just the primacy of this obligation and the basis of such discipline that the notion of *datum* or "observed fact" as defined above accounts for. See the discussion of the current debate over the theoretical-observational distinction in fn. 43 above.

[169] Maritain, *The Degrees of Knowledge*, p. 59. Essentially the same thesis, namely, that a "critical analysis of the rational processes used in each particular case" is required both to maintain the continuity of order between the discrete kinds of knowledge and to avoid the paradigmatic theory of epistemological monism, is expressed in Bernard Lonergan's study of human understanding, *Insight* (New York: Philosophical Library, 1965): see Lonergan's "Preface," pp. ix–xv, and "Introduction," pp. xvii–xxx.

In this way, an impassable gap will always attest the difference of order that distinguishes the philosopher of nature or the natural scientist from the mathematical interpreter of nature, for "it is the possibility of being ascertained through sense experience which gives the concept its positive meaning."[170]

Within the world-view as *logos* then everything rests upon the evidences established within the triangle of facts, let us call them *observed* (or at least *measurable*) facts, *reasoned* facts, and *mathematized* facts. To this we should have to add an intermediate sort of fact, more than a simple *datum* of observation and yet less than a *factum* of explanation, a dynamic web of interpretation not indifferently commingling mental constructs and observable processes, but tentatively or *dialectically* commingling them, what we must recognize and identify as dialectical or *hypothetical facts*, "facts" destined to become in the course of the extension of our field of observations and the elaboration of our scientific and philosophical understanding of nature (and in more or less modified and corrected form) either explanatory images in their turn—mathematized facts pure and simple—or reasoned facts in the ontological order of understanding.

Thus the notion of "empiriological discipline" brought forward by Maritain and defended by Simon (Maritain's book on *Philosophy of Nature* [New York: Philosophical Library, 1951] contains Simon's essay [cited in fn. 48 above] as the fourth and concluding chapter), insofar as it means something more than science of observation, *and contrary to the opinion of both Maritain and Simon*, designates purely and simply those dialectical extensions of our understanding of nature which characterize modern research-projects and which are from a philosophical point of view "science in the making." But in view of the fact that most contemporary philosophers base their conceptions of "positive" science almost exclusively on mathematical physics, it is not surprising that the dialectical use of highly refined experimental techniques and the flexible elaboration of mathematical hypotheses and laws is taken (mistaken) for science itself without further qualification[171]; nor that Maritain, in seeking to assimilate physico-mathematics to the principles of an Aristotelian noetic, should have been led (misled) into a confusion of the properties of the Platonic explanatory mode with the characteristics proper to the order of hypothetical facts—the register of empiriology—taken in itself:

[170] Simon, *art. cit.*, p. 91, See fn. 65 above.

[171] See, for example, Michael Polanyi's remarks concerning *Science, Faith, and Society* (Chicago: Phoenix, 1964); or E. A. Burtt's assessment of *The Metaphysical Foundations of Modern Science* (New York: Anchor, 1954). As Simpson remarks in another context: "This is an example of the existing hegemony of the [mathematico-] physical sciences, which is not logically justifiable but has been fostered by human historical and pragmatic factors" (*This View of Life*, p. 141).

In this very empiriological category two clearly different types of explanation can be distinguished. The empirical content (in this case the measurable) may receive its form and its rule of explanation from mathematics. Then we have an "empiriometric" type of explanation characteristic of physico-mathematical science. Or, the empirical content (in this case the observable in general) may call for a purely experimental form and rule of explanation. Then we have an "empirioschematic" type of explanation characteristic of the non-mathematical or at least non-mathematicized, sciences of observation (by this we mean that experience itself is not thought or rationalized according to the law of mathematical conceptualization, but according to the experimental schemas themselves discovered by reason in the phenomena). . . . Note that *in both cases* the empiriological terminology proper to the sciences of phenomena tends to be established in a more and more perfect independence from the ontological terminology of philosophy.[172]

It is remarkable how science, encroaching, so to speak, on future possibilities and undergoing especially the exigencies of its ideal form, uses only materially, and as though without recognizing them or rendering them competent, notions which belong to less evolved strata of conceptualization. . . . That is why in the kind of knowing with which we are at present concerned, the sciences of phenomena, the formally activating value is linked up with the elimination of the ontological and the philosophical, to the profit of a wholly empiriometric or empirioschematic explanation.

It is understandable that, for a mind limited by professional habits to the intelligibility of this degree, philosophical notions can lose all significance. It is

[172] J. Maritain, *The Degrees of Knowledge*, pp. 148–149, emphasis supplied. That a confusion of the Platonic explanatory mode with the order of hypothetical facts taken in itself is indeed present here, is indicated by the distinctive difficulty which Maritain acknowledges as consequent upon his denial of the possibility in principle of empirioschematic formulations attaining to the status of reasoned facts, or proper explanations: "This sort of purification"—the success of the alleged tendency of *all* the sciences of nature, in their very structure, to free the observable as much as possible from the ontological (why not say: to reduce the conceptual to the perceptual, the intelligible to the sensible?—see fn. 175 below)—"is particularly far advanced in physics. Either by the elaboration of new concepts or the recasting of definitions, or by a new use of common concepts (of a philosophical or pre-philosophical origin), applied exclusively to sensible verifications, sciences like biology and experimental psychology, which can be put under the empirioschematic type . . . also tend to establish a more and more autonomous notional terminology. Since they abide in a much less precarious continuity with philosophy, it is more difficult for them than for physics to isolate this terminology and to prevent its being invaded by philosophical concepts which, in this domain, would give rise to pseudo-explanations. They persevere in the attempt, however, and often seem even to prefer rudimentary conceptual tools . . . on condition that it assures this independence" (*ibid.*, p. 149).

In other words, "experimental but non-mathematizable schema," in order to be and remain empiriological in Maritain's sense, seem to require continuance in a rudimentary state of conceptualization. But is not that the entire meaning of a hypothetical as over against reasoned and mathematized facts alike? Surely there is no "law" against the child passing into adolescence, or against the adolescent reaching maturity? Quite the contrary! Why then postulate such a law stunting the growth of our rational understanding of nature?

A recent defense of this unfortunate position taken by Maritain is elaborated by Joseph J. Sikora, *The Scientific Knowledge of Sensible Nature* (Paris: Desclee, 1966); and by Maritain himself in Appendix 3 of *The Peasant of the Garonne*, trans. by Michael Cuddihy and Elizabeth Hughes (New York: Holt, Rinehart, and Winston, 1968), "A Short Epistemological Digression," pp. 270–273.

likewise understandable that the experimental sciences have in a certain sense made progress by warring on the intellect. For the intellect has a natural tendency to introduce into the conceptual register proper to the sciences meanings which derive from another register, the philosophical register, and which consequently disturb or retard experimental knowledge as such, and prevent it from achieving its pure type.[173]

But this could be so only if concepts from "the philosophical register" were opposed to the pure type of scientific explanation—and that state of affairs in its turn would be possible *if and only if* the Aristotelian explanatory mode were quite inapplicable to the details of nature.[174] Maritain's point thus seems to rest on his conception of a type of knowledge which attains the *phenomenality* but not the essences of natural realities, what Maritain calls *perinoetic* as against *dianoetic* intellection which does penetrate to the ontological character or essence of a thing.

If we grant that there is a knowledge of things in terms of phenomena and that such a knowledge in some basic sense characterizes modern science, however, it does not follow that we must accord to it an absolute status; for it may well be that we are dealing "not with an absolute difference between one kind of human knowledge in which is attained a perfectly ordered knowledge of nature (dianoetic intellection) and another which knows nothing of nature except its existence (perinoetic intellection), but rather with a type of intellection proper to man by which he knows at first confusedly and then more and more clearly as he continues his investigation."[175] Thus the fact that a vast part of modern research relies on rudimentary conceptual tools and correlations of phenomena not known to be ontologically linked constitutes a state of

[173] *Ibid.*, pp. 153–154. See further pp. 139–140, par. 4; and the comments in fn. 172 above.

[174] And in fact it is precisely "here that not only Maritain but De Koninck," and many, many others, "feel that the philosophy of nature has rather narrow limits. Both grant that it is possible to have essential definitions at the broad level of the problems raised in Aristotle's *Physics, De generatione et corruptione* and *De anima*, but beyond this they are doubtful. The forms of material things are 'so immersed in matter,' that . . . strict scientific demonstration of any but the most generic properties of changeable things is impossible." (Ashley, *Are Thomists Selling Science Short?* pp. 11–12. See the reference in fns. 42 and 142 above, and fn. 175 below.

[175] Ashley, "Does Natural Science Attain Nature or Only the Phenomena?", pp. 77–78. In the non-mathematical investigations of nature, what is known "more and more clearly as the investigation progresses" is "both the existence of a natural unit and its nature. This will be recognized, I think, by any scientist as the process he goes through in any work of research, moving gradually from a dim intuition that he is dealing with a special type of thing to a clearer and clearer notion of just what makes it special." (*Ibid.*, p. 78.)

Consequently, there seems to be no real foundation for the contention "that there is any fixed limit to the discovery of the specific essences of material things, nor to the strictly scientific explanation of their properties" in terms of proper causes; while at the same time there can hardly be any doubt "that the philosophy of nature"—explanations in the Aristotelian mode, let us say—"needs a dialectical extension both through mathematical and non-mathematical reasoning," i.e., must be supplemented "with dialectical knowledge, some of which is derived from the application of mathematics, and some from probable reasoning in [non-mathematical] physical terms." (Ashley, *Are Thomists Selling Science Short?*, p. 12).

affairs which we may characterize as "empiriological," without thereby requiring ourselves to postulate with Maritain an "irreducible distinction that must be recognized between the approach, the mode of conceptualization, the kind of relation to the real (in other words, the kind of truth) which are proper to the sciences of nature (by 'sciences of nature' I mean all sciences [physics as well as biology, etc.] which deal with things pertaining to the world of matter) and those proper to the philosophy of nature,"[176] and without thereby obliging ourselves to say without exception or further qualification concerning all of the disciplines participant in this vast effort of organized research and special investigation that "it is not their business to use signs grasped in experience in order to attain, through them, the real in its ontological structure or in its being, by a type of intellection ('dianoetic' intellection) that penetrates to the very essence (not apprehended in itself, certainly, but through those of its properties that fall under experience, outward or inward),"[177] even though it remains true to say that "they all have in common this essential character of depending (whether primarily or totally) on that intellection of an empiriological order ('perinoetic' intellection) which takes hold of the real insofar and only insofar as it is observable";[178] and the sub-distinction of the empiriological or hypothetical and dialectical order into the empiriometric and empirioschematic simply further specifies various research-projects according as they are ordered to results that are primarily of the mathematical or philosophical formal type, according, that is, as they are conceived in the line of mathematical physical or natural physical explanations: and the defining feature of empiriological knowledge as such is accordingly that it is a knowledge of phenomena constituted thanks to an intelligible element *imposed* on the data of sensation by the constructive work of the intelligence, not in an arbitrary way (as in wishful thinking), nor for its own sake and in view of some transrational end (as in poetry), but simply in an attempt "to save the appearances" by a plausible hypothesis *entertained solely for the sake of and in subservience to the data of direct experience*, i.e., the sciences of observation, that is to say, entertained *tentatively*, as was explained by Sir Isaac Newton in a formulation that leaves nothing to be desired as a clarification of this point:

[176] Maritain, "A Short Epistemological Digression" in *The Peasant of the Garonne*, p. 270, text and fn. 1. See also p. 272.

[177] *Ibid.*, p. 272, text and fn. 7.

[178] *Ibid.*, pp. 271–272, text and fn. 6. But now it is no longer a question of a difference between philosophy and science sustained in terms of a differential kind of truth—of explanatory mode, I mean, but rather of one sustained solely in terms of a differential relation to experience, without any inevitable differentiation from a formal standpoint in the epistemological type involved—a question of the difference between what Adler designates as "investigative versus non-investigative disciplines, both of which are empirical"; and now it is a question too of a difference between the order of observation and that of explanation generally: see fns. 43, 114, and 168, above.

The best and safest method of philosophizing seems to be, first to inquire diligently into properties of things, establishing those properties by experiments, and then to proceed more slowly to hypotheses for the explanation of them. *For hypotheses should be subservient only in explaining the properties of things, but not assumed in determining them; unless so far as they may furnish experiments.* For if the possibility of hypotheses is to be the test of the truth and reality of things, I see not how certainty can be obtained in any science; since numerous hypotheses may be devised, which shall seem to overcome new difficulties.[179]

The empiriological register as such therefore is a vast zone of "science (physico-mathematical and natural) in the making," or of the explanatory determination of experiences in the direction of a mathematical network (so as to become mathematized facts pure and simple) or in the direction of a properly causal scheme (so as to become reasoned facts). This vast zone of "factual" knowledge—of tendential facts, *facta vialia*—is indeed difficult to mark out, just because it is essential to it to have always shifting boundaries, and to receive its formulation in statements which tend to overlap and even contradict. It is, as we have just indicated, "empiriological" knowledge in probably the only purely defensible sense of the term, inasmuch as it is a knowledge of natural phenomena achieved thanks to an intelligible element imposed on the data of experience—not indeed arbitrarily but plausibly—a construct which *correlates* without explaining. Such dialectical definitions, or *hypothetical facts*, and the arguments based on them, do not belong strictly to the world-view as *logos*, but either to the realm of *opinion* (more or less well-founded), or pertain to the *extension* of a science (be it biology, ethics, physics, or whatever) properly so called, thus marking the twilight region in human apprehension of reality for any given individual or any given age.[180] It is principally in respect of these "facts" that it is necessary to say that "when we come to anything as complex as a world outlook, we must take account not only of methodological postulates, but of a whole background of general assumptions about what is and what is not reasonable."[181]

A vast field of critical analysis is thereby opened up. . . . The essential thing to understand is that it would be a serious mistake to conceive science [or, equally, philosophy,] in a static fashion as something achieved, "completely made." And this is true not only from the point of view of its extension and of the objects it has to know, which is obvious, but also from the point of view of its internal noetic

[179] Newton's reply to the Second Letter of Father Pardies (1672), printed in *Isaac Newton's Papers and Letters on Natural Philosophy*, I. Bernard Cohen, editor (Cambridge, Mass.: Harvard, 1958), p. 106. This indeed is the classical view, as indicated in fn. 43 above.

[180] Cf. Charles De Koninck, "The Unity and Diversity of Natural Science," in *The Philosophy of Physics*, pp. 15, 16, 23, and *passim*; and his study of *Natural Science as Philosophy* (Quebec: Laval, 1959).

[181] D. M. Emmet, "The Choice of a World-Outlook," *Philosophy*, 23 (1948), p. 211.

morphology and of its *intension* with regard to its typical forms. By the very fact that it leaves behind its prescientific basis in common sense in order to attain more and more purely the state of science, its progressive extensive growth is accompanied by a progressive intrinsic formation which brings it into line with certain determined epistemological types which it has as yet only realized partially and to diverse degrees. But though a total and homogeneous realization of these ideal types must be regarded as an asymptotic limit, it is remarkable how science, encroaching, so to speak, on future possibilities and undergoing especially the exigencies of its ideal form, uses only materially, and as though without recognizing them or rendering them competent, notions which belong to less evolved strata of conceptualization. The formal element of scientific intelligibility is current especially in the higher strata, in notions which are most typically pure.[182]

Thus the general notion of world-view as *logos* does not imply a set of definitions wholly clear and specific, still less a positivistic concentration on the physical, or a phenomenological-existential circumincision of the mental. All it requires is the possession of some essential knowledge of nature, sufficiently well-ordered to find some of the proper causes of some of the phenomena in question, and that we do not conclude with confidence beyond our knowledge of the evidence.[183] Here then is the essence of world-view as *logos*:

Nothing about material things limits human knowledge merely to the phenomena, nor the dialectical saving of the phenomena [be it verbal and hypothetical or mathematical and predictive]. Rather the phenomena are a sufficient way to the essence, provided that we undertake all the laborious work of research and experiment which the history of science proves are necessary to know the relevant phenomena.[184]

There is however a fifth kind of "fact," the tribute which emotion pays to reason in order to compensate or sometimes conceal the latter's deficiencies: let us call it the *rationalized* fact (when it is a question of concealing) or (more properly) *poetic* fact (when it is merely a question of compensating). And on this order of fact principally, *in conjunction with hypothetical facts taken not so much in their character as opinion as at the expense of their dialectical nature as extensions of scientific and philosophical understanding*, does the mythical view and *Zeitgeist* depend. For once its ordering to intellect is sacrificed, the hypothetical construct ceases to be a logical sign, in order to become rather what Maritain has aptly named a *magical* sign:

[182] Maritain, *The Degrees of Knowledge*, p. 153.
[183] "There are sophisticated theories which, arguing that no truth is quite true and no falsehood quite false, and that the notion of what is meant by 'fact' is a very obscure one, explain away our simple conviction that *sometimes, at a certain level* truth means correspondence with fact, and whatever our ultimate philosophical theory of truth, this simple conviction should be taken up into it and not made meaningless." (Emmet, p. 215.)
[184] Ashley, *Are Thomists Selling Science Short?*, p. 12.

In giving the word 'logic' a very broad and rather infrequent usage, but a usage which seems to me justified, I describe sign as a 'logical sign,' or a sign in the sphere of the Logos, when it is located in a certain functional status, wherein it is a sign *for the intelligence* (speculative or practical) taken as the *dominant factor* of the psychic regime or of the regime of culture. Whether the sign in itself be sensory or intelligible, it is then definitively addressed to intelligence: in the last analysis, it is related to a psychic regime dominated by the intelligence.

I describe sign as a 'magical sign,' or as a sign in the sphere of the Dream, when it is located in another functional status, wherein it is a sign *for the imagination* taken as a supreme arbiter or *dominant factor* of all psychic life or of all the life of culture. Whether the sign in itself be sensory or intelligential, it is then definitively addressed to the powers of the imagination; in the last analysis, it relates to a psychic regime immersed in the living ocean of the imagination.[185]

B. World-view as *mythos*

In assessing the reactions of our contemporaries to the observations contributing to the realization of the natural or essentially evolutionary state of the universe, and to the very incomplete but genuine explanations that constitute our understanding of these observations, we are at once reminded of Ernst Cassirer's great thesis "that philosophy of mind involves much more than a theory of knowledge: it involves a theory of prelogical conception and expression, and their final culmination," or failure to so culminate, "in reason and factual knowledge."[186] Indeed, "intellect is not merely logical reason; it involves an exceedingly more profound—and more obscure—life, which is revealed to us in proportion as we endeavor to penetrate the hidden recesses of poetic activity."[187] "The universe of concepts, logical connections, rational deliberation, in which the activity of the intellect takes definite form and shape, is preceded by the hidden workings of an immense and primal preconscious life . . . which is specifically distinct from the automatic or deaf unconscious,"[188] the Freudian unconscious, and of which, moreover, "Plato and the ancient wise men were well aware, and the disregard of which in favor of the Freudian unconscious alone is a sign of the dullness of our times."[189]

Much has been made in contemporary philosophy, and rightly so, of the fact that there exists a common root of all powers of the soul, which is

[185] J. Maritain, "Sign and Symbol," in *Redeeming the Time* (London: Geoffrey Bles, 1943), pp. 199–200. See also Simon, "Ideology versus Philosophy," in *The Tradition of Natural Law*, pp. 16–27.

[186] From Susanne K. Langer's "Preface" to Ernst Cassirer's *Language and Myth*, trans. by Langer (New York: Dover, 1946), p. x.

[187] Jacques Maritain, *Creative Intuition In Art and Poetry* (New York: Pantheon, 1953), p. 4.

[188] *Ibid.*, p. 94.

[189] *Ibid.*, p. 91.

hidden in an ontological unconscious or preconsciousness, and that there is in this ontoconscious dimension of the self a root activity in which the intellect and the imagination, as well as the powers of desire, love, and emotion are suchwise engaged in common that "the powers of the soul envelop one another, the universe of sense perception . . . in the universe of imagination, which is in the universe of intelligence. . . . And, according to the order of the ends and demands of nature, the first two universes move under the attraction and for the higher good of the universe of the intellect, and, to the extent to which they are not cut off from the intellect by the animal or automatic unconscious in which they lead a wild life of their own, the imagination and the senses are raised in man to a state genuinely human where they somehow participate in intelligence, and their exercise is, as it were, permeated with intelligence."[190] This is much of the meaning of man as *Dasein*.[191]

> No venture is possible without a primary gift. . . . Intuition is, as far as we are concerned, an awakening from our dreams, a step quickly taken out of slumber and its starried streams. For man has many sleeps. . . . There is a sort of grace in the natural order presiding over the birth of a metaphysician just as there is over the birth of a poet. The latter thrusts his heart into things like a dart or rocket and, by divination, sees, within the very sensible itself and inseparable from it, the flash of a spiritual light in which a glimpse of God is revealed to him. The former turns away from the sensible, and through knowledge sees within the intelligible, detached from perishable things, this very spiritual light itself, captured in some conception. The metaphysician breathes an atmosphere of abstraction which is death for the artist. Imagination, the discontinuous, the unverifiable, in which the metaphysician perishes, is life itself to the artist. While both absorb rays that come down from creative Night,[192] the artist finds nourishment in a bound intelligibility which is as multi-form as God's reflections upon earth, the metaphysician finds it in a naked intelligibility that is as determined as the proper being of things. They are playing seesaw, each in turn rising up to the sky.[193]

Thus Aristotle observes that "even the lover of myth is in a sense a lover of wisdom"[194]; and St. Thomas, commenting on this observation, turns it around, saying that the philosopher himself has a certain attachment to myths and fables, which are the proper domain of the poet:

[190] *Ibid.*, p. 110.
[191] See John N. Deely, *The Tradition Via Heidegger* (The Hague: Martinus Nijhoff, 1971), esp. Chs. V and VII, pp. 43–61 and 88–110, respectively.
[192] The "creative Night" to which Maritain here but refers in passing, he elsewhere defines and explains in a more exact treatment as *creative intuition*: see *Creative Intuition in Art and Poetry*, esp. Ch. III, "The Preconscious Life of the Intellect," pp. 71–105, and Ch. IV, "Creative Intuition and Poetic Knowledge," pp. 106–159; and the reference in fn. 187 *supra*.
[193] Maritain, *The Degrees of Knowledge*, p. 2.
[194] Aristotle, *Metaphysics*, Bk. I, ch. 2, 982b 18–19.

Whence the earliest philosophers, who treated of the principles of things after the manner of a kind of teller of tales, were called theologizing poets. . . . The philosopher is compared to the poet, or vice versa, however, simply in the sense that both treat of wonderous matters; for fables, with which the poet concerns himself, are put together from wonderous imaginings, whereas the philosophers themselves are moved to philosophizing by the spirit of wonder.[195]

When the "marvellous tale" of the poet, however, is substituted for the evidence on which authentic philosophy (and science) depends and given priority in the very order of understanding, just then are we confronted with the *mythos* of a world-view, with "a complex of ideas, convictions, and valuations which are ultimately derived from the social and psychological heritage of the person who holds them, and which he merely attempts to rationalize in his conscious philosophizing"[196]; so that in the end it must be said that in the order of *mythos* our outlook on the world depends finally (at worst) on irrational factors refractory to criticism or (at best) on transrational factors beyond its positive and direct reach.

What overcomes the *logos* by subordinating to the extent of subjugating it to a *mythos* in the mind of the thinker? It is not a hard subordination to achieve. One need only give the obscure longings of the Self sufficient freedom to triumph over the evidences of Things—an easy enough feat, which all of us perform often enough. "It is very easy for a speculative knowledge of things as they are to be transformed," muses William Carlo, "gradually and unawares, into an artistic knowledge, a production of things as the mind would like them to be. There is a bit of the creator in all of us, a legitimate heritage."[197] And Bergson has gone far in the work of assigning profound reasons for such psychological transformations:

The impulsive zeal with which we take sides on certain questions shows how our intellect has its instincts—and what can an instinct of this kind be if not an impetus common to all our ideas, i.e., their very interpenetrations? The beliefs to which we most strongly adhere are those of which we should find it most difficult to give an account, and the reasons by which we justify them are seldom those which have led us to adopt them. *In a certain sense we have adopted them without any reason, for what makes them valuable in our eyes is that they match the colour of all our other ideas, and that from the very first we have seen in them something of ourselves.*[198]

"The more I think of it," says the mythophile, "the less I see any other criterion for truth but to promote a maximum of universal coher-

[195] *In I Met.*, lect. 3, n. 55.
[196] Emmet, "The Choice of a World-Outlook," p. 211.
[197] William E. Carlo, *Philosophy, Science and Knowledge*, p. 123.
[198] Henri Bergson, *Time and Free Will*, F. L. Pogson, trans. (New York: Harper, 1960), pp. 134–135.

ence."[199] Thus by *mythos* is meant faith over against philosophy, a total explanation of the world over against inevitably incomplete understanding based on evidence. If the total explanation assumes a theological form, let us translate *mythos* as *myth;* if the total explanation assumes an atheistic or non-theological form, let us translate *mythos* as *ideology.* On either translation, the essence of world-view as *mythos* is the same: it decides without evidence, or rather, in advance of and beyond the evidence, by extrapolating where there is no assurance that extrapolation is valid. The process has been very clearly described (fittingly enough) by Pierre Teilhard de Chardin:

> The development of Faith consists in the adherence of our intelligence to a general view of the universe, by virtue of an option (freedom) or of affectivity (affection). The essential note of the psychological act of faith is, in my opinion, to see as possible and to accept as more probable a conclusion which, because it envelops so much in space and time, goes far beyond all its analytical premises. *To believe is to effect an intellectual synthesis.*[200]

If one recalls what was said above, it is plain that the establishment of a world-view as *mythos* belongs to the workings of reason in its second explanatory mode (understanding "reason" in the "deeper and larger" sense than usual indicated above), not this time indeed consisting in the verbal translations of mathematical interpretations of the sensible (*scientific myth* properly so called), but this time consisting from the first in a verbal rationalization of one's feelings with respect to evidence at hand. Following Aristotle, let us call it *poetic myth,* for that is what we are faced with. Yet both the scientific and the poetic myth are such by reason of being products primarily of reason's creative rather than its cognitive mode, by reason of belonging, so far as they can be put forward to account for anything, to reason's second explanatory mode.

> In seeking to provide an explanation of some reality, reason can be employed in either of two ways. In the first place, it can be so employed as to establish sufficiently the reasons for a fact, as in natural philosophy . . . ; but reason can also be employed

[199] Pierre Teilhard de Chardin, *How I Believe,* his own translation of *Comment je crois.* (On the authenticity of this document, see George B. Barbour, *In the Field with Teilhard de Chardin* [New York: Herder and Herder, 1965], p. 151.) It is a curious fact that Père Teilhard, who was philosophically not an idealist, was never able to formulate a notion of truth which was other than that of a purest idealism: e.g., see *The Future of Man,* pp. 36, 182, 214; or *The Phenomenon of Man,* pp. 30, 32, 59, 219. In this instance at least Simon's thesis is verified strikingly: "Men of science, willingly or not, receive their philosophical ideas from philosophers; they could not rid themselves of idealistic prejudices while philosophers were teaching idealism as the only doctrine that may account for the unquestionable ability of the mind to treat in an orderly and causal manner the universe of phenomena." (*Art. cit.,* pp. 93–94. A reasoned basis for the truth of this thesis may be found in M. J. Adler's treatment of the distinction and relation between pure and mixed questions in *The Conditions of Philosophy,* esp. in his discussion of the fourth condition of intellectual respectability, pp. 38–42, but also on pp. 44–48, 60 fn. 13, 79–91, and 95–227.)

[200] Teilhard de Chardin, *Comment je crois,* p. 2: my trans.

in another fashion, which does not establish the reasons for the facts, but which instead shows that explanatory reasons proposed on some other grounds are congruous with the given facts. . . .[201]

No use to propose this alternate explanation as the "soul" of science,[202] still less to propose it as science itself become aware of its true dimensions, a "hyper-" or "ultraphysics,"[203] for "this latter type of explanation cannot suffice to prove anything, since it may well be that appearances, the 'whole of the phenomena,' could be equally well saved within the framework of another hypothesis," not yet dreamed of by man.[204] No doubt, "like the meridians as they approach the poles, science, philosophy [here meaning principally metaphysics] and religion are bound to converge as they draw nearer to the whole."[205] Still no use to fabricate a propaedeutic to their mutual absorption. "Hyperphysics" remains distinct from all three and must be taken for what it is: world-view as *mythos*.

Nonetheless, this struggle of the human personality beyond the always incomplete evidences of knowledge is in itself a great thing, the primal workings, as we have remarked, of reason within us, where the life of sense, imagination and intellect are engaged in common. It is the source of all intuition and greatness of vision. (Thus Maritain—rightly, in my opinion—links up with what the French philosopher Blanc-de-Saint-Bonnet called "the progressive weakening of reason in modern times" and with "a so-called reason as afraid of looking at things as it is busy digging in all the details around them, and as fond of illusory explanations as it is insistent in its claim to recognize only statements of fact, the reason of those who believe that poetry is a substitute for science intended for feeble-minded persons."[206]) In itself, as Bergson has pointed out, it remains a strictly incommunicable experience, and the ideas at work in it are adopted because "they match the color of all our other ideas" (it is in this respect that an individual can express the very spirit of an age, give voice to the *Zeitgeist*) and because "from the very first we have seen in them something of ourselves" (it is in this respect that a mythos remains inextricably bound up with the obscure longings and unique moments of subjectivity, with all that differentiates poetry from science).

Hence they do not take in our minds that common looking form which they will assume as soon as we try to give expression to them in words; and, although they bear

[201] *Summa*, I, q. 32, art. 1 ad 2. See Jacques Maritain, *Creative Intuition in Art and Poetry*, fn. 33, p. 180 and pp. 168–70, *passim*.
[202] The expression is Joseph Donceel's in "Teilhard de Chardin: Scientist or Philosopher?" *International Philosophical Quarterly*, V (May, 1965), p. 256.
[203] The expression, of course, is that of Teilhard de Chardin in his "Preface" to *The Phenomenon of Man*, p. 30.
[204] Aquinas, *Summa theologica*, I, q. 32, art. 1 ad 2.
[205] Teilhard de Chardin, *The Phenomenon of Man*, p. 30.
[206] *Creative Intuition in Art and Poetry*, pp. 71–72. See also "Sign and Symbol," pp. 219–220.

the same name in other minds, they are by no means the same thing. The fact is that each of them has the same kind of life as a cell in an organism: everything which affects the general state of the self affects it also. But while the cell occupies a definite point in the organism, an idea which is truly ours fills the whole of our self.[207]

Thus it is that such ideas, the intellectual components for any given individual or any given age of the *world-picture*, the world-view as *mythos*, although they are commonly hardened into a *doctrine* sure of itself and of its power to renew everything, in reality can find expression—if they are not to lose what is authentic and noble about them—only "as fragments of a vast poem." They belong to those wondrous imaginings with which the poet (the poet in each of us, too) concerns himself. However:

One doesn't expect a poem to bring us any kind of rational knowledge whatever, be it scientific, philosophical, or theological. One expects it only to give us a glimpse of what, in an obscure contact, the poet has seized in himself and in things at the same time. But we can admire such a poem for its boldness and its beauty. And it can awaken in those who love it—particularly the [kind of] poem I am speaking of [world-view as *mythos*]—fertile ideas and lofty aspirations, and can likewise serve to overcome their prejudices and defences, opening their mind to the flame of living faith [be it secular or religious] which burned in the soul of the poet. For it is the privilege of poetry to be able to transmit an invisible flame, and through the grace of God, a flame of such a nature.[208]

But if poetry becomes a doctrine, then it has ceased to be poetry in order to become instead the wishful thinking of an individual or an age.[209] Milton and Dante knew what they were about, but, in its essential epistemological type, what they wrote belonged to the same *genre* as Plato's *Timaeus*, John Ray's *The Wisdom of God Manifested in the Works of the Creation*, Teilhard de Chardin's *The Phenomenon of Man*, or Julian Huxley's *Religion Without Revelation*.

It may be, however, that it is the evolution of the world and of life taken in its reality discernible to reason that we wish to understand, and that it is the world-view as *logos* and not only as *mythos* that occupies our attention. In this case, these cosmological syntheses succeed in teaching us nothing that all men of science did not already know, for what made them men of science in the first place was the working out of explanations so far as the evidences compelled them. Plato spoke for all to whom "faith" equals the construction of a psychological synthesis, and he spoke well, for he did not confuse *truth* with the coherence and harmony of soul-satisfying synthesis:

[207] Bergson, *Time and Free Will*, p. 135.
[208] Maritain, "Teilhard de Chardin and Teilhardism," in *The Peasant of the Garonne*, pp. 125–126. See "Sign and Symbol," in *Redeeming the Time*, pp. 223–224.
[209] See, in addition to the references in fn. 46 above, pp. 221–222 of "Sign and Symbol."

As being is to becoming, so is truth to belief. If, then, Socrates, amid the many opinions about the Gods and the generation of the universe, we are not able to give notions which are altogether and in every respect exact and consistent with one another, do not be surprised. Enough, if we adduce probabilities as likely as any others; for we must remember that I who am the speaker, and you who are the judges, are only mortal men, and we ought to accept the tale which is probable and make no more of it than that.[210]

That is why we must translate Plato's insight into the language of our own time, that it might serve as judgment not only on the noetic structure and value of the *Timaeus*, but on those among the evolutionist writings which belong to the same epistemological type. This has been finely done by Stephen Toulmin:

It is an excellent thing that men should think deeply about their place in the world of nature, and relate their goals and ideals to the process—and potentialities—of Nature. But any attempt . . . to find a single, unambiguous intention informing the whole course of cosmic history, must be regarded with suspicion. There may be legitimate objections to scepticism; but they are as nothing compared with the risks involved in philosophical wish-fulfillment.[211]

IV. CONCLUSION

We can observe by way of summing up, then, that the rise of evolutionary science in our own century exposes the excessive rationalistic character of the seventeenth and eighteenth centuries in its impatience with distinctions between different types of knowledge. At the same time, it counters this same habit of univocity which has swung contemporary science, with its inclination to regard mathematical-physics as the paradigm of rational knowledge, to the other extreme of anti-rationalism and a despair of providing an intelligible account of nature in its own proper reality. In short, the coming of evolutionary science to maturity compels us to recognize anew the intrinsic order of the human intelligence, with the essential distinctions it requires between the typical and mutually irreplaceable forms of knowing of which the mind is capable. In achieving this it compels us to accord natural science its proper value as a genuinely philosophical knowledge. It is neither a part nor an application of metaphysics, for its certitude does not rest on the necessity of intelligible being as such. As a type of explanation, it depends neither on deduction nor induction

[210] Plato, "Timaeus," in *The Dialogues of Plato*, B. Jowett translation (New York: Random House, 1920), Vol. II, p. 13. (The last seven words as cited differ from Jowett's rendition.)
[211] Stephen Toulmin, "On Teilhard de Chardin," *Commentary*, 39 (March, 1965), p. 59.

exclusively, but on the knowledge of the proper cause of something. This knowledge is not a mere projection of creative imagination, nor is it but a progressive approximation to a hidden reality that always eludes us; rather is it a very incomplete but genuine understanding of the world and of man as they are.

The areas in which our knowledge is clear and our insights successful are islands joined by bridging hypotheses. The true natural scientist is not discouraged by this fact but is determined to continue his researches until hypothesis yields to genuine insight. . . . He is humble in admitting that he knows little, but he will not be persuaded that the search is in vain.[212]

Or, as De Koninck puts it:

The bewildering progress of natural science reveals not only the bottomless depths of nature and the ineffable variety of nature's works; it shows, at the same time, the unexpected limitations of any human mind, and the devious modes of knowing it must resort to, even in the study of things immediately around us. Still, to enquire what any object of nature is, and to pursue the enquiry down to the last detail, is surely a pursuit which deserves to be called philosophy. To answer such a question, all the branches of natural science should be brought into play, and each of these remains open to infinity. At least this much we know.[213]

And since it is thus in the study of nature, at the very base and outset of our human knowledge—at the very heart of the sensible and changing multiple—that the great law of the hierarchical and dynamic organization of knowledge (on which for us the good that is intellectual unity depends) first comes into play, the hope is not unfounded that "if workers are not wanting, if unreasonable prejudices (due above all, it seems, to a morbid fear of ontological research and of all philosophy ordered to a knowledge of things—as though a philosophy of being could not also be a philosophy of mind) do not turn them back from the study of . . . philosophy that claims to face the universality of the extramental real without at the same stroke pretending to absorb all knowing into itself, it might well be hoped that we will see a new dawn break upon a new and glorious scientific era—putting an end to misunderstandings engendered in the realm of experimental research by the conflict between Aristotle and Descartes—in which the sciences of phenomena would finally achieve their normal organization, some, physics above all, undergoing the attraction of mathematics and continuing their remarkable progress along this line,

[212]Ashley, "Does Natural Science Attain Nature or Only the Phenomena?" p. 282.
[213]Charles De Koninck, "The Unity and Diversity of Natural Science," p. 24. In speaking thus of the more general context of the issues, however, it is necessary to bear in mind the qualifications indicated in fn. 114 above.

others, biology and psychology especially, undergoing the attraction of philosophy and finding in that line the organic order they need and the conditions for a development that is not merely material, but truly worthy of the understanding. Thus there would be a general redistribution springing from the natural growth of the sciences of phenomena"—be it remembered that there are two modes of empirical formulation, schematic and metric—"but one that would also suppose—and this point is quite clear—the supreme regulation of metaphysical wisdom.

"Thus the divine good of intellectual unity, shattered for three centuries now, would be restored to the human soul."[214]

[214] Maritain, *The Degrees of Knowledge*, pp. 66–67.